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DISCOVERY

A Monthly Popular Journal of Knowledge

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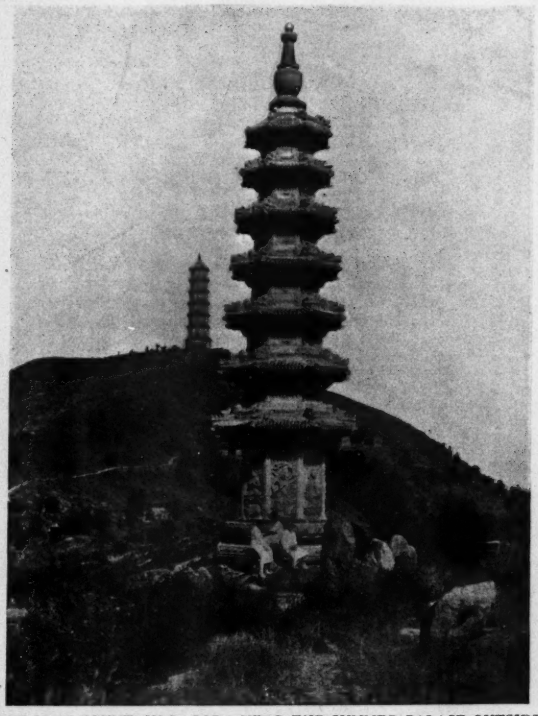

THE JADE FOUNTAIN PAGODA NEAR THE SUMMER PALACE OUTSIDE PEKIN.

CONTENTS

	Pages.
Editorial Notes	277
The Passing of China ...	279
The Immortal Taratantaleo ...	283
How Blood Breathes	285
The New Cancer Discoveries	290
Stoat Hunting Winged Game ...	292
Aurelian's Wall of Rome ...	293
Shore Fishes	295
Crowing of Pheasants ...	299
Immensities of Time and Space	300
Wild Red Deer at Exmoor ...	305
Worms as Friends and Foes ...	309
Books Received	313
Book Reviews	314

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DISCOVERY

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Editorial Notes.

Cancer is a very important problem. One has necessarily to die of something or other, but rather too many people have been untimely carried off by cancer. Statistics are dubious things at the best, but it seems that of persons over thirty years of age who die in Great Britain in a year one out of every seven dies of cancer. It is a cheerless thing to reflect that wherever you have ten people gathered together you can be fairly certain that to at least one of them cancer has a very important personal bearing. It is just as well, perhaps, that few people realize it in this acutely personal sense, but it is essential that when we see " all this fuss about cancer " in the papers that we should realize what splendid work has been done by the National Institute for Medical Research. We are about to hear of more good work from that quarter. It must be stressed that so far there is no sign or whisper of a cure. It is too early for that, but at long last the problem of the mechanics of cancer has been solved. We now know that it is due to an ultra-microscopic virus acting in combination with a particular specific agent as yet undefined, but probably produced in the cells by long continued irritation. From this point it is possible to foresee rapid advances to a successful attack. We are no longer working in the dark, ignorant of the dispositions of the enemy and only conscious of his malignant strength.

Dr. Gye,' the discoverer of the virus, was once a railway porter; Mr. Barnard, F.R.S., is a hatter, and a microscopist of international reputation in his spare time. It is a very wholesome thing for the world in general to be reminded that it is possible for amateurs to be experts; occasionally possible for keenness and whole-hearted interest in a distant field to break the shackles of social environment and attain an end. As a matter of fact, if both these men had been born into the peerage they might possibly have got together in the Mill Hill Laboratory just the same because of their interest in their work, but to a very great number of people it is a matter of heartening encouragement to reflect that in some fields of life, and in science in particular, it is the man and the work and not the outer trimmings that matter. In some incredible Utopia of the future it may be possible for quite a large number of people to work at the thing which interests them most. It was, I think, Mark Twain who wrote the story of the gentleman who was taken on a tourist trip round Heaven to meet celebrities, and was introduced to an elderly shoemaker who was the greatest military genius the world had ever produced. It is true he had never seen a shot fired. He had not been a soldier—but, nevertheless, he was the greatest military genius of all time—or would have been if he had had a chance.

* * * * *

There is something very irritating in the thought that we may have to wait generations for some particularly useful discovery because the only man of our time who could solve the problem is wasting his energies as a quarryman or a clerk. On the other hand, we may find consolation from the fact that in these cases where genius exists it will come out in spite of all attempts to extinguish it. Genius may be compared to the virus, and an aggressive, untiring intellectual energy seems to be the specific factor which enables it to break down the restrictions of environment. It is a pity there is not more of it about.

* * * * *

The news from Dayton, Tennessee, appears to be tinged with a good deal of hilarity and it is unlikely

that the residents will erect a statue to Charles Darwin whichever way the " trial " is decided on the appeal. There are disappointing indications that the authorities will help to the issue of whether John T. Scopes taught evolution, and keep the affair to this rather than allow the case to be broadened into a general battle, (*a*) about the theory of evolution ; (*b*) whether the State has a right to prohibit the teaching of fundamental philosophical principles. Here is the main text of the law under which John T. Scopes is being prosecuted for teaching evolution in the high school of Dayton, Tennessee.

* * * * *

Section 1. Be it enacted by the general assembly of the State of Tennessee, that it shall be unlawful for any teacher in any of the universities, normals, and all other public schools of the State which are supported in whole or in part by the public school funds of the State, to teach any theory that denies the story of the Divine Creation of man as taught in the Bible, and to teach instead that man has descended from a lower order of animals. *Section* 2. Be it further enacted, that any teacher found guilty of the violation of this act, shall be guilty of a misdemeanor and upon conviction shall be fined not less than one hundred ($100) dollars nor more than five hundred ($500) dollars for each offence.

* * * * *

It does not appear that Mr. J. T. Scopes has much of a case, nor is he really in the least necessary to the issues involved. He appears to have broken the intellectual speed limit of Dayton, Tennessee, and should be fined if the facts are as stated and the judge does his duty and sticks to the law. The whole question of whether it is wise or right to impose intellectual speed limits is another affair altogether. There is a good deal behind this affair which does not come out. It is not wise to think of the United States in terms of individual European liberty or to consider their system of government and local administration as operating entirely on pure and high-souled principles uncontaminated by material considerations of office holding. The true ruling powers of the United States are remarkably obscure. Political success rewards those who obey without question the instructions of somebody " higher up " in the chain of political command. The exact composition of these higher layers has defeated much earnest sociological inquiry. The fundamentalist or anti-scientific attitude is held in varying degrees of virulence in some twenty States. It is highly organized, propagandist, and well financed, and it is designed to protect nominally the gospels, actually the more material interests of reaction. In the United States public opinion is a dominant factor. It is handed out ready made and the citizens dutifully clothe themselves with the orthodox and fashionable thought. The spread of education has encouraged independent thought, and it is clear that a reasoning public is not likely to rest permanently content with the present social and political fabric of the United States. The real fight is not between evolution and the Biblical version of creation ; it is not even the more important matter of the right of a State to prohibit the teaching of accepted scientific philosophy, but it is a well-considered, cold-blooded attempt to reimpose intellectual slavery. The theory of evolution happens to be the first thing to be attacked, but the true spirit of fundamentalism is equally hostile to all thought.

* * * * *

Will the attack be successful ? One would say that nothing would stimulate the American student's belief in anything to greater height than to make it illegal. Yet, are we not told by many that Prohibition is a success, while others deny it ? In the same way we can envision a success for fundamentalism and the schooners of piratical publishers running the forbidden books of Europe. But we cannot dismiss the matter as lightly as this. We are watching the first manifestation of a political blunder of such magnitude that it is not easy to conceive. Something very massive and weighty and a controlling force in American politics has decided to sit on the safety valve of intellectual freedom. It is perhaps the only really reliable way of bringing about a revolution.

* * * * *

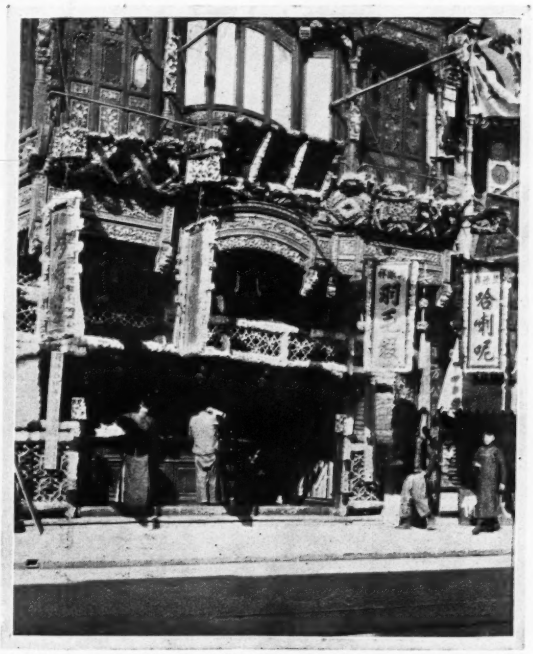
The curious thing about it is that whether the party of reaction or the party of freedom win, a most dangerous state of affairs has been provoked. We may find that a victory for evolution will turn in the hands of its more aggressive partisans into a scientific Bolshevism. There is no doubt that certain interpretations of " behaviouristic " psychology frankly suggest that the religious and moral senses on which so much of our rather shaky civilization depends are purely defence mechanisms. These new ideas may be compared to many chemical compounds. They are useful in a laboratory, but deadly in unskilled or unqualified hands. The new ideas are frankly dangerous and though held in varying degree by some of the extreme progressive element among younger scientific thinkers, they are not necessarily accepted by the main body. This American business is likely to result in a premature identification of extremist ideas with normal steady-going broad views of evolution. Advanced ideas which are likely to be misapplied need delicate handling. Monkeyville may turn out to be the undignified prelude to a revolution.

The Passing of China.

By David Boyle.

For many years we have heard people talking about affairs in China quietening down. Actually they appear to have been waking up, and the general political situation is serious. It is in the Far East that we shall see the secondary effect of the Russian Revolution, modified in detail but not in principle in order to suit the Oriental mind.

EVEN at the beginning of the present century the "Middle Kingdom," as China has been called from a literal translation of the character or ideograph that signifies the name, remained as interesting and as strange to Europeans as it was in the days when Marco Polo wrote his fascinating account of his travels over five hundred years ago. Isolated for centuries from European civilization this vast country had developed a civilization of its own in every phase of governmental, economic, artistic, and religious life, no less important as a contribution to the progress of the world than any of the civilizations that have succeeded each other in Western lands. But, like Greece and Rome towards the end of their days, China had begun to live on an accumulated atmosphere of past glories, no longer satisfying to the younger generation who had come in contact with more modern thought and progress; to them, with their opportunities of tuition in the colleges of England and America, it was of no interest to remember the great engineering feats of Yu, the canal builder, in B.C. 2300, or even the wonderful renaissance of porcelain and other arts under the Ming dynasty at the comparatively recent date of the fifteenth century A.D.



Chinese shop in the Nanking Road, Shanghai, a few yards from the police station, the attack on which was the prelude to the present troubles.

Modern Times.

From the days of the Tai-ping rebellion in 1851-1864, through the Boxer rising in 1900 to the outbreak of the Great War, a small but steadily growing minority in China has lost no opportunity to revolt either against foreign interference with their country or against the old and effete Imperial rule which belonged to a truly bygone age. And yet in 1905, for instance, China was still a land of beauty and of mystery, of mediaeval pomp and custom, of untiring energy in agricultural production. Peking was still the centre of Imperial power and the glass of fashion, and its Forbidden City still guarded secrets which none but the highest rank might share.

Trade.

The Viceroys of the Son of Heaven still ruled over their provinces with comparative ease and success, and the prestige of the foreigner who, except for a few missionaries and daring travellers, lived almost entirely in the Treaty Ports, was still sufficiently powerful to inspire respect and often affection in the simpler folk of the country districts. Shanghai, Hankow, and Canton, among other Treaty Ports had become hives of industry for foreign trade, and as far as the outward eye could see (and read, in Customs returns) the country was prosperous and on an upward curve in economic values.

But underneath, as the old Greek tragedian said, there was a festering sore; the trend and growth of European civilization, which had already transformed Japan, and, through America and England, had driven its arrows of ambition into the youth of the educated classes in China, was at complete variance with the governmental customs and usage of the last two thousand years. The inevitable occurred, and at a touch in 1911 the Imperial power was swept away, and that wonder of the world, the Temple of Heaven

The Soochow Creek at Shanghai. A contrast of ancient and modern. It is the great outlet for the silks and produce of the country for shipment overseas.

in Peking, lost its High Priest, and became a picnic ground for the foreign tourists. No single rallying point remained for the provinces to look to for guidance, and chastised as the people may have been with whips, they were soon to lament the advent of scorpions.

From then till now China has been nominally a Republic, with its seat of government at Peking as in the days of the Empire ; actually it has become a vast nursery of sporadic local administrations, all jealous of each other, and some in the hands of men who have but one ambition, the personal aggrandisement of themselves at the expense of their neighbours. Once the old Imperial power with its centuries of prestige had fallen, the whole fabric of government as we know it crashed into innumerable pieces ; one stable element has alone survived, the foreign-administered Customs service which, based on the vast volume of trade entering and leaving the Treaty Ports, provides the only revenue that keeps China on the map as a Power in the modern and economic sense of that word.

Control Collapse.

No prestige, no respect, no obedience to authority, no common aim, no popular sentiment exists any longer in China in regard to the so-called Peking government. Chang-so-lin, the Dictator of Mukden, may by force of arms control Manchuria and the territories north of Peking ; remnants of Wu Pei Fu's power still exact obedience in parts of Middle China and the Yangtse valley ; the teachings of Sun Yat Sen and his child, the dreaded Kuo-Min-Tang, visibly permeate the Canton area and provinces of the south ; but government as a whole for or by the people is utterly non-existent.

For some years now the Powers have stood by and watched this disappearance of an unified control and administration of China, hoping against hope that one party or another would prove strong enough to impose its will upon the country, hoping that out of this strange oriental crucible would be born some strong man who would proclaim himself dictator and lead " those from the Land of Sinim " into the vacant

Russian Influence.

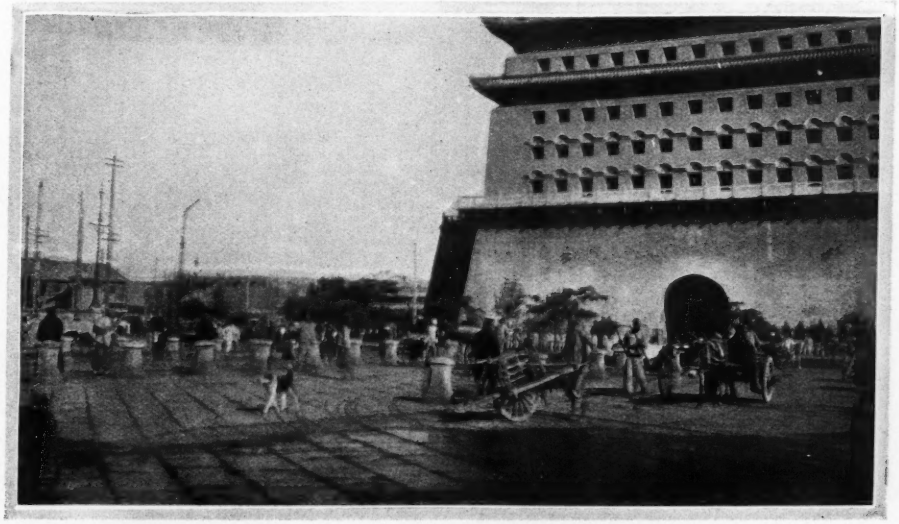
seat in the councils of the nations. Nothing has happened but growing anarchy, nothing but the disappearance at last of even the simple contented nature of the toiling millions of people who inhabit an area of nearly five million square miles stretching from Tibet to the Pacific and from Indo-China to Mongolia and the Russian provinces of Eastern Siberia. The Powers have stood by, idly in some cases, in all puzzled, contented to collect when possible the interest on the many foreign loans contracted over a period of years and secured on the Customs revenues, mildly expostulating when damage to life and property of their nationals made it necessary to indite despatches to an impotent Foreign Office at Peking, fearful of interference without each other's sanction, and " losing face " in oriental eyes at every step.

By geographical position and by racial connexion the two Powers obviously best fitted to profit by this

disintegration of the power-house of the East are Russia and Japan. In the latter case the Chinese have before their eyes the object lesson of an Asiatic race which, sunk in a life of absolutely primitive conditions while China was already a civilization, has in the last fifty years won for itself a position of equality with the proudest nations of Europe. But the Chinese do not like the Japanese, and have always been suspicious of overtures from that direction. They prefer to deal with European nations; they prefer to copy from the original and not from a replica however cunningly fashioned. And so just when salvation might have been had, at a price, from that quarter, the non-vocal but none the less powerful sentiment of the Chinese as a whole turned as they have always done to the West for inspiration.

Here was Russia's chance. Russia, no longer an Imperial power with all the pomp of its despotism and the chariot-drawn misery of its million serfs, but a Russia of apparent democratic thought and liberty, the professed deliverer of oppressed peoples, a sword of nationalism against the supremacy of the few. Slowly and secretly in the fertile soil of the Chinese student minds the seed of an oriental Bolshevism has been ripening to action. It abandoned its Communistic principles of the destruction of family life, of the spoliation of private property; these tenets could never attract a people to whom ancestor-worship and the ownership of even a tiny plot of land, are life itself. It adopted new methods. It found thousands and thousands of young men, students who in the Imperial days would have spent their lives puzzling out some obscure passage in Confucius, full of the theoretic inventions of a Western world, tossed here and there on the waves of restless thought that are distracting youth in every Western University, discontented, seeking they know not what; and it proceeded cunningly and quietly to proclaim the doctrines of nationalism as only prevented from realization by the presence of the hated foreigner.

It has always been, even in the old Imperial days, a safe rallying point for malcontents to put down all present miseries to the "foreign devil"; either he was robbing the country of its own trade profits, or he was attempting to seize land for his own use, or he was interfering with that strange Chinese superstition called "Feng Shui" (which would take pages to explain to a Western audience) or he was proclaiming alien gods in the shape of Christianity and attempting to wreck the teachings of Confucius, of Laotze, or of Buddha. Even under the Dowager Empress, that wonderful woman who ruled China for over forty years, the forces of reaction and visionary reform triumphed for a time. Before their time, it is true; they culminated in the Boxer rising of 1900, an anti-foreign rebellion directly produced by anachronistic periods of reform, a rebellion sternly put down by the Great Powers, who for a few years and for the last time earned respect throughout China for their action. The reformers failed then; in our language they had "backed the wrong horse," and when, after the Dowager Empress' death in 1908, the reform movement became



The Chienmen Gate at Peking. There is no traffic problem, but the illustration shows three methods of conveyance. Peking cart with mule, a ricksha, and the Chinese wheelbarrow.

again uppermost, the leaders were careful to dissociate from it any anti-foreign propaganda.

For that very reason it has failed to survive except in name. China, though nominally achieving a democratic liberty, became even more oppressed by a myriad of local leaders and uncontrolled tax gatherers than ever it had been under the Empire. The Bolshevists have realized this, and have at last succeeded in yoking the anti-foreign virus which has never wholly died in Chinese veins to the perfectly normal desire of national self-expression.

They, the Bolshevists, have no illusions; they know that the whole movement under their control is designed to destroy British trade and drive out British enterprise. In all their published writings on the Far East, the leaders of Moscow have definitely stated that Central Asia and all the States bordering on India are outposts from which the Soviet should be able to threaten England, and they have worked in China to that one end.

But the Chinese, poor souls, are being unwittingly used as tools for the satanic machinations of the Moscow murder-gang, with the result that from Hong Kong to Peking, and from Shanghai westward to the cities of Szechuan strikes and boycotts, riots and outrages, are being fomented against the foreigner as the source of all evil. Trade is at a standstill; the rich silks of Soochow, the teas of Fuhkien, the cotton, rice, bean and other crops of the fertile Yangtse valley are losing their natural outlet to the markets of the world, and the cultivator, who forms probably nine-tenths of the population of the whole Chinese territory, is one step nearer what is always near to him, famine and penury. The wonderful architecture and art treasures of China are being looted or are decaying; the memorials of a civilization that was famous in Tudor times are crumbling from neglect; the very scholarship of China that was renowned throughout the world is dying from inanition.

We are witnessing in our own time the passing of an Empire as glorious as ever Rome or Greece.

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ZINC.

ACCORDING to French biologists, solutions of zinc salts such as zinc sulphate prevent the coagulation of blood *in vitro* and *in vivo*. Life has been experimentally maintained in subjects from which the higher nervous centres had been removed, and in which aeration of the blood stream was maintained by artificial respiration.

PLATINUM IN CANADA.

A MINING pioneer of Vancouver, Charles F. Shaw, has discovered a deposit of chrome iron containing a large percentage of platinum. The deposit is on the banks of the Tulaman river, British Columbia, and the news of the discovery has excited such interest that over a hundred claims have been staked already. Platinum from Tulaman is not a new development; over 20,000 ounces have been won from other deposits in this region. Mr. Shaw's deposit, however, is the richest yet discovered there.

ZINC AS A PRESERVATIVE.

IT is well known that until recently copper salts were very extensively used to preserve the green colour of tinned peas. Now it is quite common for tins of these to be marked as copper-free. The peas, however, do not lose their colouring and analytic examination reveals that this is preserved by the use of zinc salts, as much as 3.1 grains per pound being present in some samples. The colour-preserving properties of copper and zinc salts are about equal, but the toxic properties of the latter are considerably less, although some, such as the cyanide, are distinctly poisonous.

A WEED KILLER.

THOSE who dislike having their garden paths overgrown with unsightly weeds will welcome details of a recent German patent. Certain benzine derivatives known as the sulphonamides are either powdered on to the weeds, or else dissolved in water and sprayed on them. The most potent of these compounds recommended by the patent are the sodium and calcium paratoluene sulphonamides. By the sound of it it should kill any weed. The compounds, it is said, may be added to the gravel before laying the paths in order to prevent any weeds from growing.

VALUE OF AMMONIUM NITRATE AS A FERTILIZER

AMMONIUM nitrate performs an extremely useful function in fertilizing certain crops, especially grasses, as it enables them to take the best advantage of any phosphorus compounds present in the soil. When, however, the soil is a sandy one, ammonium nitrate is not the best fertilizer to use. The plants split it up into ammonia and nitric acid, and in a sandy soil they absorb more ammonia than nitric acid. This free acid, being left in the soil, accumulates, with the result that the soil is quickly rendered acid. It is therefore advisable to make certain of the type of soil before applying ammonium nitrate as a fertilizer.

The Immortal Taratantaleo.

By Colin Matheson, M.A., B.Sc.

Here we have a little mystery on the border region between Science and Letters. What was the immortal Taratantaleo which perplexed Alexandre Dumas?

WHO, or what, is the taratantaleo? When we say it is an animal the reader will, no doubt, start thinking of tarantula spiders, and conjure up a vision of some huge hairy creature of repulsive aspect and armed with poison fangs. But the taratantaleo has no kinship with the tarantula; perhaps, indeed, it has no kinship with any living creature. Perhaps it is but a figment of the imagination, based on some creature insufficiently observed in an age when scientific accuracy was not understood as it is to-day. Yet one is tempted to believe otherwise, to think that this marvellous creature not only exists but is known to present-day science, though under a much less grandiloquent name.

Alexandre Dumas.

If you would read of the taratantaleo, you must turn to "The Arsenal" which forms an introduction to one of the weirdest imaginative stories of Alexandre Dumas, "The Woman with the Velvet Necklace." In "The Arsenal," Dumas takes the opportunity, as did Victor Hugo, Alfred de Musset, and Sainte-Beuve, of acknowledging his obligations to Charles Nodier, librarian at the Bibliothèque de l'Arsenal at Paris. Nodier had led a full and stirring life; he was a man of wide learning and considerable talent, and his home at the Arsenal was a centre and a rallying-place for young men of still greater talent than himself—the "Romanticists" of 1830—much of whose work was influenced by him. Poet, novelist, philosopher, and scientist was Charles Nodier, as was often the case in those old days before knowledge had reached the dimensions that now make it impossible for one man to take all of it for his province. He it was who was shown the definition of a crab, composed by an academician for the famous dictionary of the French Academy, and was asked for his opinion on it. The definition read—"Crab; a small red fish, which walks backwards." "There is only one mistake in your definition," said Nodier—"the crab is not a fish, is not red, and does not walk backwards; otherwise it is perfect." Nodier had studied natural history in his youth; and it is to this period of his activities that his discovery of the taratantaleo belongs.

One day, when eighteen years of age, that is to say, in 1798, he was studying under the microscope a little moist sand from the gutter, when his eye lighted upon a strange object. A tiny animalcule, shaped like a velocipide, was moving across the slide, having two wheels which it worked very rapidly, and which helped it through the water like the paddles of a steamboat. So absorbed did the student become in his examination of this remarkable creature, that he quite forgot an important engagement he had made. He continued sketching and examining his find, until suddenly the neglected appointment flashed through his mind. Leaving the microscope, the slide, and the animalcule on it just as they were, he hurried away, hoping to resume his investigations later.

It was late when Nodier returned home, and he was tired and went to bed. Not until next morning therefore did he recollect his living velocipide. But on going to his microscope, he found that the sand had dried during the night, and the poor taratantaleo, which doubtless required some moisture to support life, was lying still and dead. The tiny body lay on its side, the wheels moved no longer. Nodier, disconsolate that he could no more study the habits of his peculiar find, reflected that nevertheless the body was worth preserving as that of a new and hitherto undescribed species. Carefully, therefore, he transferred the sand with the taratantaleo to a small box and put it away in a cupboard, promising himself to show the creature to the first scientist who should venture to climb his six flights of stairs.

The Miracle.

But apparently no scientist did so for some time and, according to Dumas, Nodier forgot the corpse of the taratantaleo for three months, six months, perhaps a year. But one day he happened to notice the box, and felt inclined to see what change the passage of time had wrought in the animal. It was a dull rainy day, and in order to see better he went to the open window, and there transferred the contents of the box to the slide of his microscope. As Nodier was gazing down the barrel of the microscope at the little motionless body, which did not appear at all decomposed, a marvellous thing occurred.

A drop of rain driven by the wind fell on the slide and wetted the sand and then, it seemed to Nodier, the taratantaleo slowly began to move. The body

of Rotifers lived in a small pool on the top of a granite block. At intervals this pool was swept dry by the wind, and only a little dry dust remained. Yet when the pool was refilled with rain, the Rotifers were to be seen moving about actively and evidently none the worse for their long desiccation—it seemed, in fact, obvious that they wanted only the water to bring them to life again. But a certain scientist took home some of the dust left when the pool was dry, moistened it, and found that the tiny creatures did not revive. What had actually survived during the spells of drought was the eggs, which developed rapidly on obtaining moisture and took their parents' place.

This, however, is not always the explanation; some Rotifers certainly do survive prolonged desiccation, and it is possible that such a Rotifer, and the imagination of Charles Nodier, were the parents of the immortal taratantaleo.

How Blood Breathes.

By Doctor Eric Ponder.

Oceans of blood have been spilt, yet scientifically speaking we know very little about blood and its physiological mechanisms. The red blood cell still holds mysteries which the scientist is seeking to solve.

WHETHER the fact can be used as an argument for the theory of evolution or not, it is very interesting to observe how, as one ascends the scale of creation, the vital mechanisms of animals become more and more adapted to their needs—an adaptation which has often been commented upon because of its very obviousness as well as because it forms a useful plank in the platform of those who hold that everything in Nature is directed towards a foreseen end. Nowhere is it better exemplified than in the respiratory mechanism of animals, and in the manner in which gases are conveyed from air or water to the tissues, a subject of sufficiently recent interest and sufficiently recently investigated to warrant its being brought before the readers of DISCOVERY.

Simple Mechanisms.

As everyone doubtless knows, each living cell requires for its nourishment the gas oxygen, derived principally from the air or, in the case of aquatic animals, from the surrounding water in which it is dissolved. The oxygen is used up in certain reactions which occur in the protoplasm of the cell, the result of which is the production of the waste product carbon dioxide, or CO_2. It is plainly essential that the supply of the nutritive gas and the removal of the waste product should go on continuously, for a lack of the former, or a failure to remove the latter, must result in an impairment of the functions of the cell, or even in its death.

In the case of the unicellular organisms, such as Paramœcium or Amoeba, this gaseous interchange occurs in the simplest possible way, the oxygen being taken up from the water in which the animal lives, and the CO_2 being given off in a like manner. This primitive arrangement serves quite well even in more complex animals, such as the jelly-fishes and the sea-anemones, through the bodies of which the sea-water flows, carrying with it an abundant supply of oxygen, which passes continually to the tissues. The sea-urchins and star-fishes, too, although having their organs in by no means the same free contact with the surrounding water as have the jelly-fishes, possess a very similar method of gaseous supply, for their body cavities are filled with water which communicates with the exterior by means of little pores and which bathes all the tissues, supplying them with the dissolved gas. As the animal becomes more complex, however, this simple arrangement ceases to be adequate, and we find the tissues bathed, not with the external medium, but with a fluid contained in blood vessels. Thus it is in many worms and molluscs, such as the oyster and the whelk tribe; the fluid in the blood vessels carries sufficient oxygen dissolved in it to supply the tissues and, in its turn, gets oxygen from the air or from the water. The waste CO_2 is disposed of in a similar way; it is given off by the cells of the tissues, and taken up into solution by the fluid of the blood vessels. Eventually it passes from this into the air or the surrounding water, and thus out of the system of the animal.

Higher Developments.

The efficacy of this simple arrangement clearly depends on the oxygen requirements being comparatively small. In some of the more developed animals, however, we find the beginnings of a much more efficient system of gas transportation, for in the larger crustacea, such as the lobster, in the octopus tribe, and in the air-breathing molluscs such as the

righted itself, the wheels commenced to turn, the taratantaleo, entombed so long in the little box, came to life again and soon was swimming actively across the slide.

Ten times Nodier repeated the experiment, and ten times the animalcule, dried up and dead, awoke to life again at the touch of its native element, water. Hence it was that Nodier credited his taratantaleo with immortality, and described it with such pride to his friends. He would, says Dumas, describe to you the taratantaleo's manners and customs and caprices, he would have told you of its love affairs if, from the moment he discovered its immortality, he had not condemned it to celibacy, reproduction being useless where resurrection exists.

Unluckily one day, when Nodier was preparing to repeat the test, a gust of wind carried away the dry sand and the animalcule, and thus deprived him for ever of the phenomenal taratantaleo, this immortal which he had picked up in the gutter.

Was it a Rotifer?

Now, although one is apt to dismiss this story as an exaggeration based on some imperfect recollection of Nodier's, anyone with a knowledge of zoology will, we think, be inclined to wonder whether in the taratantaleo we have not simply a whimsical and rather fantastic vision of a creature well-known to modern science, the Rotifer or wheel-animalcule. Let us read the description of a Rotifer given by Baker, one of the earliest students of the group in this country, in a letter addressed to the President of the Royal Society. "I call it a Water Animal, because its Appearance as a Living Creature is only in that Element. I give it also for Distinction Sake the Name of Wheeler, Wheel Insect or Animal; from its being furnished with a Pair of Instruments, which in Figure and Motion, appear much to resemble Wheels. It can, however, continue many Months out of Water, and dry as Dust; in which Condition its Shape is globular, its Bigness exceeds not a Grain of Sand, and no Signs of Life appear. Notwithstanding being put into Water, in the space of Half an Hour a languid Motion begins, the Globule turns itself about, lengthens by slow Degrees, becomes in the Form of a lively Maggot, and most commonly in a few minutes afterwards puts out its Wheels and swims vigorously through the Water in Search of Food. . . . If the Water standing in Gutters of Lead, or the Slimy Sediment it leaves behind has anything of a Red Colour, one may be almost certain of finding them therein." He has much more to say on the subject, but enough has been quoted to show the similarity between Nodier's taratantaleo and Baker's Rotifer. Several species of taratantaleo had, in fact, been known for some time before Nodier made his discovery.

What, then, are the real facts about these creatures as we know them to-day? They are microscopic animals, the largest not exceeding one eighth of an inch in length, and are of cosmopolitan distribution, some living in the sea, some in brackish water, but the great majority in fresh water.

The body of a Rotifer is divided into three regions: first, the head, ending in the disc, which bears the ciliary wreath, this corresponding to the "wheels" of the early observers; secondly, the trunk, containing the viscera; and thirdly the foot, containing muscles, nerves, and cement-glands.

The disc, which terminates the head, varies greatly in shape and in the arrangement of its parts. One may compare it with a circular funnel, covered on the inner side with cilia—fine threads or lashes—and with the mouth at the bottom. The prominent rim of the funnel bears two zones of cilia, the inner zone, or "hoop" being the coarser and the outer or "girdle" the finer, while a finely ciliated groove lies between the two zones. Either or both of the zones may be interrupted in places, the position of the mouth may be shifted, and the ciliary wreath, as a whole or in part, may be festooned or lobed, while there are many other variations in different species. The cilia are in constant motion and strike backward more strongly than forward, thus bringing a current of water to the mouth and thence over the surface of the body. In this way food is brought to the animal, while the fresh water always passing over the body ensures a constant supply of oxygen, besides removing the products of respiration and excretion. In addition to bringing food and oxygen to the animal, the cilia may carry it forward—in all free-swimming Rotifers the cilia are the main organs of locomotion.

Was it Immortal?

Apart from the power possessed by certain species of resisting prolonged drought in a state of suspended animation, the Rotifers are not usually long-lived. Maupas, who experimented with the genus Hydatina, found that the greatest age of the unfertilized female was thirteen days, that of the fertilized female seven or eight days, that of the male only two or three days. In most Rotifers the males are small and degenerate, and having no food-canal cannot eat; so that one certainly would not look for immortality among the male taratantaleos!

In addition it must be noticed that the apparent revivification of Rotifers is not always real. A colony

RED BLOOD CELLS OF THE NEWT.
Observe the large part of the cell filled with the dense nucleus. The respiratory pigment, hæmoglobin, lies around this.

snail and slug, there is a distinct blood system, much like our own, in which the oxygen is carried in combination with a "respiratory pigment" instead of in simple solution. If these animals bleed, their blood can be seen to be not red but blue, owing to the presence of this pigment, which is called hæmocyanin. When hæmocyanin is united to oxygen it is blue; otherwise it is colourless. Although this pigment does not combine very actively with the gas, its presence is a great improvement over the transport of gas by simple solution which is found in the less developed animals, for greater quantities of oxygen are able to be carried to the tissues by its means. As the blood passes through what corresponds to the gills in these creatures, the colourless pigment takes up oxygen, and thus becomes blue; it then passes in the circulation to the remote parts of the body, where it gives up the gas to the needy tissues, becoming again colourless.

Pigment Influences.

Hæmocyanin is only one of many respiratory pigments, and is allied to the red hæmoglobin, the oxygen carrier in the vertebrates, and to a green pigment, chlorocruorin, which serves for gas transportation in certain worms whose blood is green. It is also allied, in a rather indirect way, to chlorophil, the colouring matter of plants, which plays a part in their respiration. It is only recently that its oxygen-carrying power has been recognized, and that it has been shown to play a part in the respiratory processes of the animals in which it is found.

One seeks in vain for any rule as to the respiratory pigments in the invertebrates. Some have hæmocyanin, others the green pigment, chlorocruorin, and others the pigment found in the blood of mammals, hæmoglobin; others again have no such pigments at all, while still others, such as the insects, dispense with not only respiratory pigment, but even with blood in any form, the oxygen being carried to the various parts of the body by innumerable tiny tubes which penetrate everywhere. Some invertebrates which have a respiratory pigment do not apparently employ it: the crab Limulus, for example, has in its blood vessels an abundant supply of hæmocyanin which unites with oxygen readily enough, but which gives it off with great difficulty. The presence of these pigments appears to be more of an increase of the efficiency of gas transport than an absolute necessity, and it is impossible to lay down any rule as to when some particular pigment will be found, when another, and when none at all.

Cell Enclosed Pigments.

The peculiarity of all these pigments in the invertebrates is that, except in a few very exceptional cases, they are found dissolved in the blood stream. This in itself constitutes a disadvantage. The oxygen-carrying power of the blood, other things being equal, plainly must depend on the amount of pigment present, and the amount of pigment must necessarily be small, because if there were much in solution the viscosity of the blood would be increased unduly, and it would flow with difficulty. Further, the pigment being in simple solution tends to pass out of the vessels and accumulate in the spaces between the tissue cells, a place where it is not wanted, and where its oxygen-combining powers are valueless. A great deal would therefore be gained if the pigment were confined to cells floating in the blood instead of being dissolved in the blood stream, for then not only would it be kept within these proper channels, but it could be as concentrated as much as one wished without affecting to any extent the viscosity of the blood. The more pigment concentrated in the cells the greater would the oxygen-carrying power of the blood be, and thus the transport of gases would be rendered more efficient by the enclosure of the pigment in cells, without there being any accompanying disadvantages.

As we pass from the invertebrates to the vertebrates we find this improvement brought about in a very noticeable manner. In the former, out of the innumerable animals which have respiratory pigments, only three or four have them enclosed in cells; in

the vertebrates there is not a single case in which an oxygen-combining substance is free in the blood stream. Chlorocruorin and hæmocyanin are found no longer; the respiratory pigment hæmoglobin, held in little cells called erythrocytes, completely replaces them. The gain in efficiency by this arrangement is very considerable, for not only is hæmoglobin many times more active than other respiratory pigments, but it is present in the blood to a far greater extent, for nearly a third of each erythrocyte is made up of it. As these cells pass through the blood vessels of the lungs the hæmoglobin has ample opportunity of taking up atmospheric oxygen, which it carries to the cells of the tissues in every part of the body. Even the most humble vertebrate is thus better equipped in its mechanism of gas transport than is such a creature as the jelly-fish, for not only has it an efficient oxygen-carrier in the form of hæmoglobin, but it has this pigment concentrated in special cells, and therefore employed to the greatest advantage.

The simple method of examining the web of the frog's foot in order to see the red blood cells passing along the blood vessels. The frog is shown lying on the stage of the microscope.

Importance of Red Cells.

But the possibilities of improvement of the gas-transporting mechanism do not by any means end here, for the lower vertebrates, such as the lampreys and fishes, are poorly equipped compared to the mammals. In the lampreys, the erythrocytes or red cells as they are called from the colour of the pigment in them, are flattened disc-like bodies, containing a large nucleus around which the respiratory pigment is disposed as a number of minute granules. So too in the fishes, amphibians, reptiles, and birds, the red cells are largely occupied by nucleus, and only the portion of the cell around this filled with hæmoglobin; in these cases, however, the pigment is not in the form of granules, but is evenly distributed throughout the outer parts of the cell, being held in by a stout membrane which envelops the erythrocyte. In the mammals, on the other hand, the entire cell is devoted to the pigment, for there is neither nucleus or any other structure present; hæmoglobin occupies the whole erythrocyte, and is present in great quantity. These cells are plainly much more adapted to carry oxygen than are those of the birds or fishes, if for no other reason than that none of the space inside them is occupied by a nucleus—a structure which, however important it may be to the life of a cell, is useless from the point of view of oxygen transportation.

These red cells are of a considerable historical interest apart from their modern one. They were first discovered by Swammerdam in 1658, but the discovery was looked upon as so unimportant that it was not published until nearly a century later. A few years later the anatomist Malpighi observed the red cells in the blood of the hedgehog, but thought that they were fat globules, and so narrowly missed the honour of being the first to lay claim to the important discovery. In 1673, the Dutch linen-draper and inventor of the microscope, Leeuwenhoek, while testing one of his primitive instruments, examined a drop of human blood and saw therein "innumerable little globules"—the red cells—from which time the study of these bodies began in earnest. About one hundred years later it was shown that the cells were not globules, but flat discs, and that they were devoid of a nucleus, and therefore unique. The function of

Gulliver's Travels.

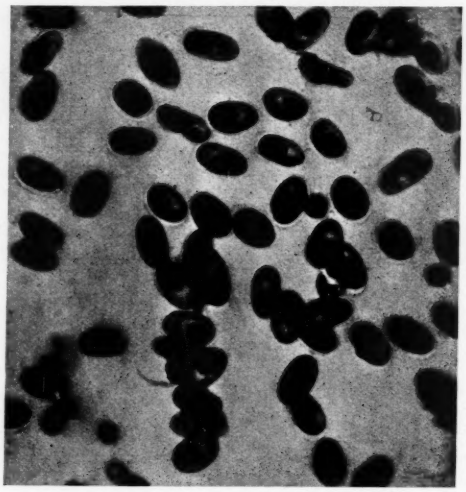
the cells, however, was not very clearly recognized until much later; it is surprising to find such an eminent physiologist as John Hunter saying that the red cells cannot be of much significance in the physiology of the animal, and almost pathetic to read the claim of one of the leading authorities in 1880, who proudly says, "As a result of researches extending over two hundred years, we can affirm with certainty that the mammalian red blood cells are non-nucleated discs of a reddish-yellow colour, having a diameter of 1/3200th of an inch." It seems poor fruit for two hundred years' research. In fact, it is somewhat of an under-estimate. A certain Gulliver, like his namesake, had undertaken a series of travels to all parts of the globe, and had collected the blood of about every known animal with a view to carrying

out an examination of their cells. His results are published as a most valuable and very formidable table of the sizes of the red cells in the vertebrates. By the end of the last century, too, the function of the red cell in respiration was pretty well worked out, and a mass of literature regarding its structure already in existence.

Unsolved Mysteries.

Despite all this, it is surprising how many problems connected with these cells still remain to be solved. To begin with, the red cell of the mammalia is a curiosity in that it apparently possesses no internal structure at all, and certainly no nucleus. It is derived from a more primitive cell, found only in the bone marrow and never in the circulating blood, which has a well-marked nucleus but, as this cell develops and is ready to pass into the blood stream where it is to exercise its oxygen-carrying function, the nucleus is lost. What the structure of the mature cell is has been a problem which has exercised physiologists very considerably for the past hundred years. It has been suggested by some that the cell is a kind of jelly-like disc, not unlike a little sponge, in the meshes of which the pigment hæmoglobin is held; others, again, think that it is more like a little balloon, made up of a strong membrane inside which the pigment is held in solution. First the sponge theory received favour, then the balloon theory; the exponents of the sponge structure then established their case more strongly, only to have it broken down in recent years by the balloon enthusiasts, so that at present the matter hangs in the balance once more.

Another problem relates to the size of these red cells. In any one type of animal the size is very constant, but it varies greatly in different species. The cells of the elephant are the largest, and only a little larger than those of man – that is, about 0.009 millimetres in diameter. The cells of the sheep, on the other hand, are only about half this size, and those of a certain deer of the Himalayas only half as small again. There seems to be no good reason why one animal should have large red cells and another small ones, although some interesting explanations have been put forward. It used to be thought that the size of the cell and the amount of pigment it contained had some relation to the activity of the animal and its needs for oxygen– a quite unsupportable idea; and it has also been suggested that there is some relation between the size of the cell and the height at which the creature normally lives. This has something to be said for it, for it is a fact that people who live in the mountains develop, after a time, smaller red cells than those who live at a lower level,



THE RED CELLS OF MAN.
Observe how they cling together like piles of coins. This occurs only after the blood is withdrawn. When in the vessels they are separate. Note the round flat shape, and the absence of nucleus. The whole cell is filled with respiratory pigment.

a beautiful example of adaptation to environment, for the small cells appear to be more efficient oxygen-carriers than large ones, and their smallness is compensated for by an increase in their number. Many of the animals, too, whose cells are of small size are, or were at one time, inhabitants of the high lands— the Himalayan deer, for instance, the sheep or the goat, are all animals whose red cells are small, and which live in the hills.

The Blood Serum.

The entire mechanism of oxygen transportation, and especially its improvement as one ascends the animal scale, is therefore one of great interest. It is only comparatively recently that the part played by the respiratory pigments of the lower animals— hæmocyanin, chlorocruorin, and the like – has been recognized, and it is therefore only now that we can arrange the matter in its proper sequence. The transference of gas by simple solution in circulating water, the conveyance of it by a respiratory pigment, the enclosure of the pigment in cells, and the increase in the power of the pigment to combine with oxygen, are all stages, as it were, in the increase of efficiency which we find accompanying the development from the most primitive form of animal. To a certain extent, however, these respiratory pigments are a luxury, for many animals are able to survive even if all the cells containing hæmoglobin are withdrawn from the blood, or are rendered incapable of carrying out their function, for the fluid part of the blood

can dissolve enough oxygen to keep the animal's tissues alive, provided that a sufficient quantity is supplied. In coal-gas poisoning—commonly called "pink death" from the beautiful cherry colour of the compound which the respiratory pigment hæmoglobin forms with the poison, the presence of which gives the dead person a look of perfect health—the cells are unable to combine with oxygen, for they are already saturated with coal-gas; the person therefore dies from lack of oxygen. But if he can be put into a chamber containing oxygen under high pressure, the fluid part of the blood will dissolve enough to carry to the tissues and to keep him alive until fresh blood is transfused into him, thus giving him fresh red cells to undertake his oxygen transportation. Under ordinary circumstances, however, the amount of nutritive gas supplied in this way is far too small for the needs of the body, hence the necessity of the hæmoglobin, the presence of which in the blood enables some seven times as much oxygen to be carried.

It is a very simple thing to see these little red cells actually in the circulation. All that is required is a low-power microscope and a frog. If you place the web of the frog's foot on the stage of the microscope and focus the instrument on one of the innumerable little blood vessels which lie in it, it is the simplest possible matter to see the red cells within the vessels, passing along in single file. Because of their red colour they are easily recognized, and form one of the most interesting pictures which can be obtained with even a very cheap microscope. The proceeding causes the frog no inconvenience at all.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX.

FOLLOWING a highly successful Conference held at High Leigh, Hoddesdon, in September, 1924, of those interested in special libraries and agencies for the collection, treatment and distribution of information, a representative Standing Committee was appointed to ensure continuity of the work, and to arrange for a Second Conference. The Standing Committee has been fortunate in obtaining assistance from the Carnegie United Kingdom Trustees, and the proceedings of the First Conference have just been issued. The Committee has decided to name the body thus called into being "The Association of Special Libraries and Information Bureaux."

The Second Conference of the Association will be held at Balliol College, Oxford, during the week-end 25th to 28th September, 1925; full particulars can be obtained from the Organizing Secretary at the Offices of the Association, 38 Bloomsbury Square, London, W.C.1.

As accommodation is not unlimited, early application is advised, and in the event of restriction being necessary preference will be given to the duly accredited representatives of organizations, whether scientific, commercial, industrial, social, political or educational, concerned with the systematic use of sources of information.

A HOLIDAY COMPETITION FOR AMATEUR PHOTOGRAPHERS.

BURROUGHS, WELLCOME & CO. offer five prizes of one guinea each for the five best holiday snaps taken during July or August, 1925. Typical holiday photographs are required, such as can be secured by amateurs with any camera. Prints only must be sent in the first instance. Prints may be of any size, but each one submitted must be accompanied by the July or August light table from the "Wellcome" Photographic Exposure Calculator, Handbook and Diary, 1925, and be addressed to "Photo Competition," Burroughs, Wellcome & Co., Snow Hill Buildings, London, E.C.1, on or before 12th September.

Negatives must be developed with any "Tabloid" Developer, and those from which winning prints are made must be loaned for one month to Burroughs Wellcome & Co., who are to have the sole right of reproduction. Negatives will be returned if desired. The decision of Burroughs, Wellcome & Co. will be final in regard to points covered by the above rules and any others that may arise. No entrance fees. Entry forms will be sent free on application to Burroughs, Wellcome & Co., Snow Hill Building, E.C.1.

THE ALBERT MEDAL.

THE ALBERT MEDAL of the Royal Society of Arts for the current year has been awarded to Lieut.-Colonel Sir David Prain, "for the application of botany to the development of the raw materials of the Empire." Sir David Prain is one of the most distinguished of living botanists. When Director of the Royal Botanic Gardens at Calcutta he developed the Government cinchona plantations of India, and organized a system for the cheap distribution of quinine through the post offices, thereby making the drug familiar in every village of India and saving unnumbered human lives. The Albert Medal was instituted in 1863 and is awarded annually "for distinguished merit in promoting Arts, Manufactures and Commerce."

The New Cancer Discoveries.

By B. M. A.

Medical science has now reached a definite discovery of the first importance. The cause of cancer, long a mystery, has been found, and from the new knowledge it is probable that definite protective or curative methods will be evolved in due course. It is a triumph for British research work.

NOT only the medical world but the scientific and lay public have been thrilled to hear that Dr. Gye and Mr. Barnard, F.R.S., working jointly at the National Institute for Medical Research, have succeeded in finding a virus believed to be the cause of cancer. The announcement has been made by the Medical Research Council, and it is understood that it has been independently confirmed by an authority of the Imperial Cancer Research Fund. The work, like all scientific work, will necessarily have to be verified and confirmed by independent workers, but we may take it as fact. The results were actually arrived at some time ago, and have been very carefully checked before the knowledge was given to the world.

The New Theory.

The cause of cancer has been a mystery. One school claimed that it was due to parasitic infection, either a microbe or possibly a protozoon. The opposition school claimed, on the other hand, that it was not due to a microbe at all, but was caused by certain external factors such as tar, dust, or paraffin, stimulating the cells to morbid and malignant growth.

There were perfectly good theoretical arguments for and against both sides. No one had been able to find a particular bacterial growth invariably associated with cancer tumours but, on the other hand, the mechanical irritant school were not able to prove that a given irritant inevitably produced a malignant tumour. Neither theory could account for the causal agent, explain its working, or demonstrate it experimentally.

Gye's great work has been to show that both theories were right, but that both were dependent on one another.

Cancer is probably caused by a germ which he has isolated and which has been photographed under the ultra-microscope by Barnard, but these germs will not " cause " cancer except when a something, and so far a something undetermined, is also present with the infection in order to produce suitable conditions.

The cancer germs, if isolated and injected in a pure state, do *not* produce cancer. An extract of a cancer tumour prepared and sterilized so that all cancer germs are eliminated does *not* produce cancer.

But a mixture of pure germs and the germ free extract of tumour *does* produce a cancer.

This unknown substance is called a " specific agent," and Gye's discovery that an organism which may be harmless in the pure state can yet be deadly when combined with a suitable " specific agent " is going to revolutionize our outlook on bacteriological problems.

In the case of the cancer organism the nature of the specific agent is still undetermined, but Gye's previous work on gas gangrene showed that the gas gangrene bacteria were not harmful except when particular inorganic substances such as silica or chloride of lime was also injected into the wound. In the same way silica dust is seemingly intimately associated with the development of some forms of consumption. The specific agent in cancer appears to be something far more complex, probably a secretion produced by the cells in a state of irritation. The virus or germ is common to tumours in mice, fowls and man, the strain of virus isolated from mouse cancer produces cancer in fowls, but only if injected with a " specific agent " made from fowl tumours. Thus we have to each type of animal cancer a common virus or living germ, but also to each a special " specific agent " effective only for one particular kind of animal.

So far research has not proceeded to the point where remedial or curative measures could be considered. Now knowing the causal agents it is not too much to hope that a remedy will be found probably along the lines of vaccination or anti-toxin. But it should be generally recognized that at the moment no cure other than operative surgery exists. Experiments on mice give some indication that a vaccine which will immunise against cancer can be prepared. It may be long before we can safely prescribe this treatment for the human being.

Wait for Results.

Here a further warning. There has been more crank and quack nonsense talked about cancer remedies and cancer palliatives and causes than most other diseases. The new discovery will give impetus to a variety of quack theories aimed at attributing the symbiotic relation of the virus and the specific agent to anything from constipation to vegetarianism. This is all hot air. The average medical man knows

extremely little about cancer. The professional biologist knows less and says so, but there exist rare spirits who can, to their own satisfaction and the delusion of others, combine the flatulent dietetics of the cellulose school, a Jules Vernian type of cytology and the mysteries of the Pyramid of Cheops into a large book of ultra-microscopic value. The new discoveries will undoubtedly produce a froth of unsubstantiated speculation, and it will be as well not to anticipate that the remedy will follow hot-foot upon the discovery of the causal chain. The preparation of a vaccine from the newly-discovered virus may be, owing to the unknown secondary factor, a difficult business to achieve.

The New Ultra-Microscope.

In the past authorities have denied that cancer was attributable to a virus because no particular bacteria had been isolated, and the suggestion that it was due to an invisible filter-passing virus appeared to be negatived, in that rabbit cancer was not transmissible to fowls and other than by the graft of living cells. Experiments in the communication of the disease from species to species or even within the same species were abortive.

To-day we know that this was due to the specific agent, and that the living quantity, the cancer virus, is common to many mammalian species. The tumour which was such a baffling affair to the morbid pathologist now falls into its proper place as a result of Nature's frenzied efforts to get rid of the virus.

The isolation and culture of the virus itself and its identification is therefore a matter of prime importance. This has been established by Mr. Barnard's (who was President of the Royal Microscopical Society in 1918-19) development of a special type of super-microscope. The instrument was made by the leading firm of English opticians, Messrs. R. and J. Beck, and is a new and extremely important weapon in the armoury of science. An extension of the methods used by our premier microscopist and the use of the same perfect apparatus and beautiful equipment may lead to even more astonishing discoveries concerning the little-known processes of the life of the cell. A very wide range of general research has now received an enlargement of its potential horizon. All diseases thought to be due to filter passers—measles, sleepy sickness, distemper, foot-and-mouth and whooping cough—will yield their secrets.

The new Barnard-Beck microscope is a very different affair to the conventional instrument. It is more like an engineer's tool than an optician's instrument, yet it surpasses anything ever designed for accuracy and precision. Mr. Barnard's work has further upset some of the pre-existent dogma concerning accepted methods of micro-photographic technique. The Continent and the Americas will once again have to acknowledge British supremacy in optical, mechanical and technical fields.

The instrument has no body tube so that adjustment of the ocular does not necessarily disturb the focussing of the objective. The main point is, however, a combined dark ground and direct light illuminator. In this the central illuminating system is a series of quartz lenses, while surrounding it is a parabolic dark ground illuminator. The filter-passing viruses are so small that it is necessary to employ a light wave of very short wave-length in order to detect them in the field of the dark ground illuminator. Mr. Barnard found that a mercury lamp with a wave-length of 546 $\mu\mu$ (milli-microns) was the best illuminant. Using this light he was able to detect the existence of ultra-microscopic organisms in the field of the dark ground illuminator. In order to resolve these and get some idea of structure and detail, it was necessary to use an even shorter wave-length of light.

He therefore made his visual examination by the green band in the mercury spectrum 546 $\mu\mu$ and changed over to the ultra-violet light of 257 $\mu\mu$ for photographing them. The shorter wave-length of the ultra-violet discloses on the sensitive plate detail imperceptible to the eye working with the mercury lamp.

Illumination Devices.

The problem of focussing the virus elements under the shorter wave-length was met mechanically. The combined dark ground and direct illuminator was attached to a micrometer-focussing device whose head is divided. An object focussed in light of a known wave-length can be adjusted for photography by light of a different wave-length simply by rotating the divided head, the requisite number of divisions corresponding to the difference in wave-length. The central stop which stops transmitted light reaching the objective while the apparatus is being used with the dark ground illuminator is withdrawn, and the central quartz system comes into play.

As the light used for photography is in the ultra-violet range, and ultra-violet rays are stopped by glass, it follows that the whole optical system of objective, condenser, ocular, slide and "cover glass" must be made of quartz, as are the accessory illuminating systems on the optical bench.

It is probable that Mr. Barnard's work will revolutionize much of existing bacteriological technique.

In the ordinary way the presence of bacteria in a culture is discernible to the naked eye. The tube of serum or agar becomes turbid; in plate cultures spots appear. When dealing with these ultra-microscopic viruses there is no outward and visible sign of proliferation. The serum does not cloud or opalesce.

The structure of the newly-detected bodies appears to be that of globes or spheroidal bodies, round the edges of which grow small buds or projections. It is yet too early to come to definite conclusions on this, but Mr. Barnard is inclined to think that this method of growth is the only one which could satisfactorily cope with the peculiar difficulties of surface tension which in bodies of this infinitesimal size might preclude the normal method of multiplication by division. The original papers of Dr. Gye and Mr. J. E. Barnard appear in the *Lancet* for 18th July, 1925. The magnitude of this achievement in ultra-microscopic technique may perhaps be realized by the lay mind if we consider that the cancer virus is about $\frac{1}{10}$th of the size of the ordinary bacteria, such as a small micrococcus whose diameter is usually taken as one micron (0.001 m/m or $\frac{1}{25000}$ inch).

A cancer organism of 0.1 micron diameter may be considered as being magnified to a sphere an inch in diameter. A man of the average size of 5 ft. 8 in. magnified on an equivalent scale would be over 260 *miles* tall !

Stoat Hunting Winged Game.

By H. M. B.

In the Lammermoors recently I saw a covey of grouse rise from the heather in a much flustered and startled manner. I was not sufficiently near to them to be the cause of their sudden alarm, so concluded that the disturbance was in some way unusual, and marked down the place. Almost immediately I saw something moving at the exact point from which the grouse had risen, and made it out to be a stoat, which was now sitting bolt upright on a sandy hillock, apparently watching the startled birds. They alighted about eighty yards away, for the chicks being no larger than quails they were evidently incapable of a more sustained flight.

Immediately they were down, the stoat set off at full speed in their direction. He did not take the least trouble to keep out of sight, but followed the crest of a ridge which was covered with green grass closely cropped by the rabbits. Thus I was able to follow him till he took to the heather within a few feet of the point at which the young grouse had alighted, whereupon the covey again took wing, coming straight back towards me. As I was perfectly motionless they alighted in the deep heather on the opposite side of the road, and within three minutes I again saw the stoat as he darted across the road in a direct line with the crouching birds. Unfortunately he saw me, and at once made off in the opposite direction.

I would not have thought that the sight of the stoat was sufficiently penetrating, nor his viewpoint sufficiently elevated, to enable him habitually to hunt winged game in this manner. It may appear at first sight that he had set himself a hopeless task, yet in view of the effect that the proximity of one of these deadly little killers has upon hare or rabbit, he may have been practising a game he had many times found successful. It is conceivable that the young birds, repeatedly finding their pursuer at their heels, would have become more and more panic-stricken, crouching closer and taking shorter flights each time, and thus ere long the stoat might have accounted for the major portion of the covey, killing them one by one as they crouched in the heather. I have seen a stoat hunting birds when there was deep snow on the ground, the little animal diving in and out and endeavouring to surprise birds on the surface, but I have never before seen one following birds in flight with a view to running them down.

Recent research by Messrs. Beman-Varilla and Techowzres suggest that dilute sodium hypochlorite solutions are bactericidal at a distance and without contact. It is believed that the molecule of salt, when acting on organic matter, emits during its decomposition a radiation which has a bactericidal effect on neighbouring zones not in contact with the area of the reaction.

Nutrition research on rats fed on a diet of dried skim milk powder shows that though the diet will support life the reproductive function is suppressed. The addition of traces of iodine or fluorides is sufficient to restore this.

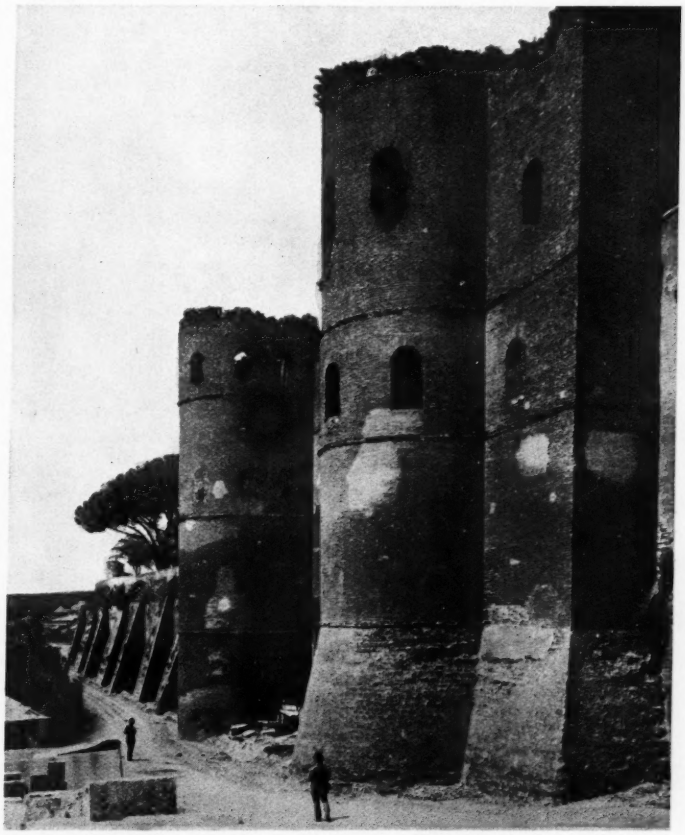
Among the metallic substances traceable in the human body nickel must now be included. It does not occur in the fats or in muscular tissue, but is found associated with keratine and also in the liver.

Aurelian's Wall of Rome

By Ian A. Richmond, B.A.

Very interesting archaeological research is being done on the gates and walls of Rome. These have been so altered during the passage of centuries that very complex problems are introduced. The author's investigations are doing much to throw light on the earliest remains.

ONE of the first acts of the Emperor Aurelian (A.D. 270-275) was to provide Rome with a wall; and this formed a central point in a long series of fortifications inspired by the Alamannic raids into Italy of A.D. 268 and 270-271, the Gothic invasion of Thrace in A.D. 268, and the Frankish pillaging of Gaul in A.D. 275. In Italy the invaders were stopped only at Lake Garda and at the Apennines, a sufficient proof that the danger to the capital of the Empire from folk-wanderings was still real. The fortification of Rome was therefore an emergency measure, for the people were riotous and panic-stricken, and the urgent need was an obstacle sufficient to keep out barbaric cavalry until troops arrived on the spot to deal with it. Hitherto it has been believed that Aurelian was responsible for erecting a city wall and gates of a type quite out of keeping with the requirements or fashion of the time; and these notes give the preliminary conclusions drawn by the writer as Gilchrist Student at the British School of Rome, and as beneficiary of the Charles Oldham Trustees of Corpus Christi College, Oxford, from detailed examination of the wall itself, so far as they relate to the problem of what Aurelian built.



THE PORTA ASINARIA.
The battered first story is a recent addition.

Nine of the sixteen ancient gates can now be inspected, including part of the defensive Porta Labicana, preserved by Gregory XVI. This gate and the Porta Tiburtina have two-story travertine curtains bearing inscriptions of Honorius, and resembling those of the Portae Latina and "Chiusa"; while the curtains of

The Gates

the Portae Ostiensis and Pinciana have travertine first stories and thus may also be contemporary. This leaves the Portae Nomentana and Asinaria as existing claimants to an Aurelianic form, since the Porta Appia is disqualified by G. Lugli's discovery of an early travertine arch embedded in the marble curtain.

The remaining western tower of the Porta Nomentana raises no doubt. It is constructed of brick-faced concrete with bonding-courses, of a style well up to the standards of Aurelian's time. Above the second story come two string-courses, which originally ran below three round-headed windows; and proportion suggests that an embattled top came not far above them. This was matched by a similar tower; and the curtain must have had three rather large windows set in a row above a single arch; so

much is shown by Parker's rare photograph of the Porta Salaria, which once had a precisely similar west tower, heightened in later times, as Vasi shows ("Monumenti di Roma," I, pl. iii, 1747). The result is a simple type of gateway that occurs all over the Roman world. In Rome it may be welcomed as Aurelian's typical gate, which is represented by the semi-circular bastions of the Portae Portuensis (demolished), Ostiensis, Latina, Nomentana, Salaria (demolished), Pinciana (a later copy), and of the original Porta Flaminia. But only the Nomentana preserves its original facing to give the age of the type.

Typologically the Porta Asinaria falls between the Balkerne Gate at Colchester and the south-west gate at Pevensey, to take Romano-British examples. It differs from its sister

Examples.

gates in having four-storied semi-circular bastions pushed forward in front of a square compartment, reached by staircases in a square side-tower. Originally the two square elements may have been planned to stand alone, but this intention was abandoned soon after building had begun. In the two upper stories were windows and a different arrangement of stairs from that below; but neither windows nor string-courses on each bastion correspond, although their similar brickwork assigns them to the same period. The gateway arch was single; the second story of the curtain contains a row of five windows interrupting an earlier embattled breastwork; in the third the original three windows have been increased to six; the fourth was once open to the sky, but its later covering is now ruined. This ill-balanced gateway is unique in Rome, and although the parapets just mentioned show that in present form it did not belong to Aurelian's original scheme, brickwork suggests that it is certainly not later than Honorius. No important road led therefrom, and Dr. T. Ashby attractively connects its massive form with the great palace behind it.

The Portae Appia and Flaminia present many complications. But in the meantime it may be noted that Dr. Ashby's argument for the Imperial date of the Porta Flaminia's square bastions of marble (*Town Planning Review*, Dec. 1924, pp. 76-79) is strengthened by the fact that both gates possessed peculiar bosses on their stones, which elsewhere on the wall are not earlier than Honorius, although the technique which caused them is at least as old as Augustus; while similarity of both gates would emphasize the equally supreme importance of the roads which they spanned. This hypothesis becomes worth testing, for since it is proved that the Flaminia had early semi-circular bastions (*ibid.*), and that the Appia has a travertine arch, so placed that the entrance must once have been double and the present marble bastions could not have existed, it may be asked whether both gates were not once alike in resembling the vanished Porta Portuensis (see Maggi-Maupin-Losi's plan of Rome, 1625). At all events, there is now a strong case for believing that not much later than the opening of the fifth century, as brickwork on the Porta Appia shows, both gates were given a form not unlike that which travellers along the Via Appia may still see.

PORTA APPIA.
The curtain once had two arcades of windows.

Just as Aurelian selected a simple type of city gate, so his choice fell upon a simple pattern of wall. For since ancient and modern authority unanimously declares that he was the first to build a wall round

Imperial Rome, it must now be conceded that in his time the place of the great arcaded structure described in the "Itinerarium Einsiedlense" was taken by a wall not more than twenty-five feet high. This can be seen embodied within the later structure in the Viale Pretoriano or in the Piazzale Ostiense. In many places also, notably the Viali Ardeatino and Labicano, parts of its front can be recognized by their better brickwork and by their parapets which remain visibly embedded within the later structure, although repeated refacing of the wall has reduced the percentage of such remains per curtain. There is, however, no doubt that, if each curtain were cut, traces of the early wall would appear in varying form, since in some places (*e.g.*, Piazzale Ostiense), the arcade was later built upon the early wall, and in others (*e.g.*, the Decenniae), it must have been cut through it or have run behind it. The kind of towers that flanked this wall probably did not differ radically from those which now exist at the upper end of the Viale del Muro Torto, or in the Viale Tiburtino; but this question needs further examination.

At the moment it would be rash to fix when the arcade was added and the wall heightened except to state that some alterations to parapets in the Piazzale Tiburtino after their completion shows that this did not happen until the first building scheme was regarded as complete. On the other hand this clearly is the first great alteration on the wall, and therefore it cannot be later than Honorius when, in A.D. 402, literature and inscriptions both attest a well-known renovation. Actually brickwork suggests that the operation under discussion could have taken place some time before. And it would be attractive to believe that Aurelian or Probus changed their plans and made the wall worthy of the city it encircled, or even that Constantine completed some Maxentian scheme. But the very divergence of possibilities shows that the whole matter needs further careful inquiry, and for the present we may be content with having reached with some certainty about what Aurelian actually built.

Shore Fishes.

By Marie V. Lebour, D.Sc., F.Z.S.

Fish nesting is hardly as well-known as birds nesting, and we still do not know where some kinds of fish deposit their eggs. In many cases the father fish takes care of the nest until the babies hatch out.

THOSE who can visit the sea-coast would do well to watch the habits of the shore fishes which are second to none in their interesting ways and not difficult to study. An accessible piece of rocky coast with plenty of pools and a good stretch uncovered by the tide—that is the ideal hunting-ground for the small fishes, and also the ideal breeding-place for many of them, for in spring and summer most of these fishes that live amongst the rocks also rear their families there, and the hiding-places for their eggs are delightfully varied. In speaking of shore fishes, however, those living beyond low water but not far from the shore are also included, a large number living amongst the sea grass and other seaweeds in the shallow bays.

The First Find.

Nearest to high-water mark and therefore the first to be encountered is the Common Blenny or "Shanny" (Fig. 1), which is to be found in almost the first pools we come to, sometimes even in those not filled at every tide, but left until the high spring tides flood them periodically. Here underneath the stones lurks the little fish, or even climbs by means of its fins on the dry rocks. It feeds on the rock barnacles, and browses on anything it may find, and is provided with sharp chisel-edged teeth which will even bite us if we are not careful, although the small bite would not do much damage. In early spring the Blenny chooses a very safe place for its nest—so safe that it was only discovered in recent years where the eggs were laid. A deep rock crevice, sometimes more than a foot deep, covered periodically by the tide and with only a small slit for entrance and sometimes only a few yards from high-water mark, that is the Blenny's nesting-place. Here, on the underside of the rock, the female lays her eggs in a large spreading layer, each egg a small round yellow mass with deep purple blotches; and here the male fish watches the eggs unceasingly until the time comes for them to hatch. As hatching time approaches the purple colour disappears and the baby fishes can be seen inside the eggs, their eyes sparkling brightly with metallic lustre. It is nearly always the male fish that undertakes any parental duties that are necessary after the eggs are laid, the female usually taking no interest in them after deposition. The patience of the male is extraordinary, for he never

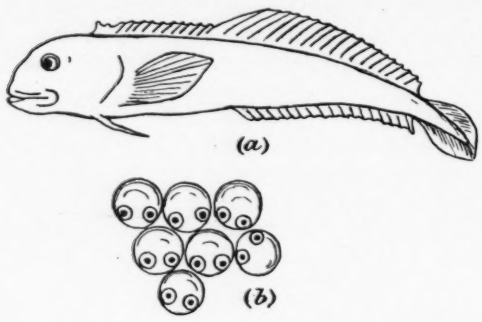


FIG. 1.—COMMON BLENNY.
(*a*) Adult 3½ inches long; (*b*) Eggs each 1.5 m/m. across.

fails in his watch until the eggs are hatched. It is generally impossible to reach the Blenny's eggs without breaking the rock with hammer and chisel, so inaccessible to any one but the fish is the spot chosen. When hatched the small Blennies disperse into the surrounding rock-pools and fend for themselves.

A little lower down between tide-marks we may come upon the "Butter Fish" or Gunnel, a relation of the Blenny. Lift a big flat stone and hear a flapping of a fish's tail. It is probably the Gunnel showing his disgust at being disturbed. In the very early spring its eggs may be found in a round ball, about four times as big as the parent's head, the eggs being white and opaque. These either occupy some rock crevice or empty shell or, more frequently, the fish itself is coiled round them prior to depositing them in some safe spot where they will be carefully watched until hatched. In this case the male and female take turns in coiling round the eggs until they become compressed into a nice round ball and both watch over them whilst hatching; but it is exceptional for the mother to give so much attention to the eggs. Like the Blenny, the newly-hatched Gunnel swims away into the surrounding rock pools.

The Casual Rockling.

There is another rock fish sometimes even more common than the Gunnel, which lives in the pools, known from its habits as the Rockling (Fig. 2). This is related to the Cod, Whiting and Haddock, and like them sheds its eggs freely into the sea so that they are not attached to anything and not cared for at all, but directly they are laid they are at the mercy of the winds, waves and currents, and may be carried away very far from their original home. The commonest Rockling is known as the Five-bearded Rockling, as it possesses five processes on its head, one on its chin, two just above the upper jaw and two behind these farther back on its head. Like the Gunnel its body is elongated and somewhat eel-like in shape and it has the same habit of flapping its tail when disturbed. It is usually a dark reddish-brown in colour, the Gunnel being a greenish-brown with conspicuous spots along its back. The Rockling's egg is small and round and contains an oil globule. When nearly ready to hatch the baby fish can be seen curled up inside and soon hatches out as a very small larval fish quite unlike the adult, transparent with black spots on its body and still containing a fair amount of the remains of the yolk sac on which it fed in the egg, and on which it still continues to feed for the first few days of its free existence. The eggs and young may be carried right out to sea and are frequently to be found floating some miles from the coast to find a final resting-place in some suitable rock-pool far from their original home. A close relation of the Five-bearded Rockling is another Rockling known as the Mackeral Midge, a little silvery fish on which the Mackerel feed in huge numbers; the name being sometimes given to the young of the Five-bearded Rockling and others.

Sucker Fishes.

A word may be said here about the fins of a fish. These are of two kinds, the paired and the unpaired. The paired fins correspond with our arms and legs, called the pectoral and pelvic fins respectively. The unpaired fins are situated on the back and under-surface of the body and round the tail. In swimming the body is propelled by the lashing of the tail, the unpaired fins usually acting as a keel, the paired fins, especially the pectorals, being used for steering and also balancing. The pelvic fins, although corresponding with our legs, are sometimes situated very far forward, so far that they may even be in front of the pectorals, as in the Rockling. In many of the shore fishes the pelvics are modified so as to form a sucker for clinging to the rocks, and there is a certain group known as the Suckers on account of this peculiarity. On the coast of Devon we have the Cornish Sucker, only about three inches long, living between the tide-marks under stones. Its pointed snout, triangular head and two large blue spots make it easy to recognise. In the spring it lays its eggs in a large layer on the under-surface of a stone, the eggs looking like drops of golden dew, and, fixed by its sucker to the stone, watching over the eggs is the little parent fish. Other rock suckers, belonging however to another group, are known as the Sea-snail and Montagu's Sucker, and a very large one, sometimes over a foot long and enormously broad, is the Lump-Sucker, well-known between tide-marks on the north-east coast, but usually

found below low-water mark in the south. This greenish monster with its skin covered with wart-like protuberances is the most faithful of fathers, watching its eggs with untiring affection and allowing itself to be bodily removed rather than swim away from them. The eggs are laid in a large lump (it is said that several females lay their eggs together) with cavities here and there to allow for air to get at the eggs, the lump, about six inches or more across, is attached to a rock and watched over by the male until the young are hatched.

Gobies' Nests.

The Gobies also have modified pelvic fins although these do not form such true suckers as those mentioned above. The Rock Goby (Fig. 3) is perhaps the most perfect example of parental care in fishes. The male prepares a nest, in this case an inverted stone, usually scraping the ground from underneath (other Gobies living beyond the low-water mark frequently use an inverted shell), and awaits the coming of the female to lay her eggs. She may look at the nest and not approve of it and go away, but if the situation be to her liking she will lay a large layer of eggs on the under-surface of the stone. This accomplished, she takes no further interest in her offspring but she leaves the rest to the male who instantly proceeds to take charge, never leaving the eggs except to frighten away enemies, keeping the eggs well aerated by fanning them with his pectoral fins and generally exercising every care possible to ensure protection for them. In an aquarium tank one of these little fishes was watched whilst guarding its eggs and was seen to take hold of a large starfish much bigger than himself, run away with it to the other end of the tank and return to his eggs, repeating this time after time when the

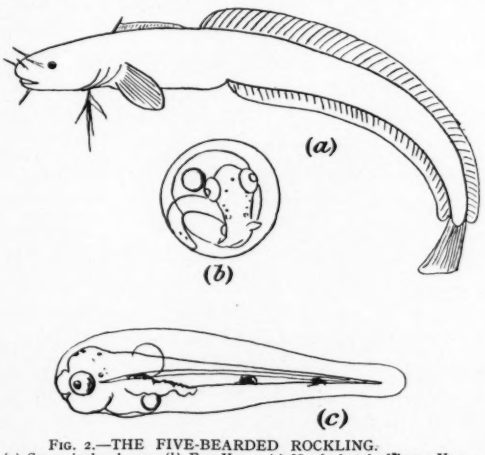


FIG. 2.—THE FIVE-BEARDED ROCKLING.
(*a*) Seven inches long; (*b*) Egg X20; (*c*) Newly hatched larva X20.

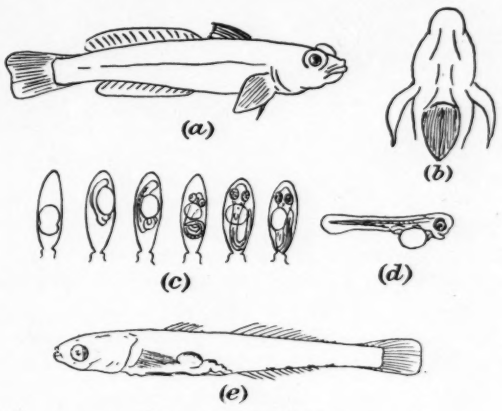


FIG 3.—THE ROCK GOBY.
(*a*) Adult 3½ inches long; (*b*) Under surface showing modified pelvic fins; (*c*) Eggs with embryos at various stages of growth 2.6 m/m. high; (*d*) Newly hatched larva, 4 m/m. long; (*e*) Young goby 11.5 m/m. long.

starfish was placed in his vicinity. The egg of the Goby is enclosed in a vase-shaped capsule measuring about two and a half millimetres in height and attached to the stone by a beautifully meshed basket-work of fibres, the wall of the capsule being quite clear and transparent, so that the development of the little fish may be watched for the whole of its growth, from the one-celled stage when newly-laid, through the division stages into a ball of cells and the growth of all the organs. When the eyes become coloured, the pupil black, and the blood is red, which is in about a fortnight from the time of laying, the fish is ready to hatch and emerges as a tiny larva with a simple fin round its tail, the fin to be split up eventually into the separate unpaired fins of the adult fish. The Rock Goby is dark brown with a mottled skin, thick-set and fairly fat with a round head. It measures about three and a half inches in length and is of more massive build than the two other common Gobies, the Speckled Goby and the Two-spotted Goby, both of which live beyond low-water and are not left uncovered by the tide. These two lay their eggs inside empty shells such as the Oyster, Scallop and Cockle, the eggs hanging downwards from the inside of the half lying uppermost.

Like a Bird's Nest.

Fishes that make true nests are the Wrasses and Sticklebacks, many others such as the Pogge or Armed Bullhead and the Sea-Snail laying them in seaweed. One of the Wrasses common in shallow water makes a large nest in a rock crevice only reached by the water at high tide and raised far above the water at low tide. The nest looks like a big bird's nest, measuring several inches across, and composed of seaweeds, limy algae or corallines and plant-like animals commonly

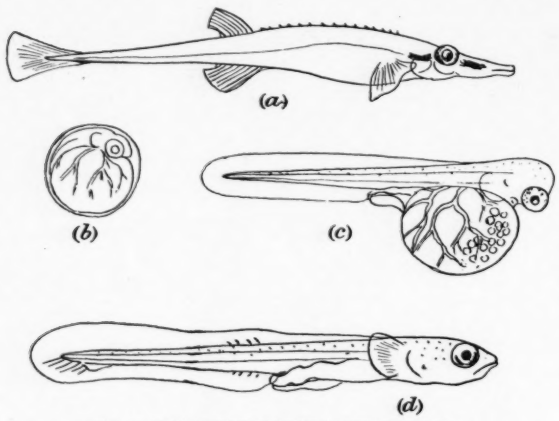


FIG. 4.—THE FIFTEEN-SPINED STICKLEBACK.
(*a*) Adult 5 inches long; (*b*) Egg 2 mm. across; (*c*) Newly hatched larva 6.5 m/m. long; (*d*) Young, 14 days old, 12 m/m. long.

called zoophytes. These are all massed together into a suitable space between the rocks and the tiny eggs are deposited loosely inside it and scattered irregularly through its substance. In this case no fish has been found watching the eggs, so presumably having had so much provided they are allowed to hatch out by themselves.

Other Egg Methods.

The Stickleback (Fig. 4), like its freshwater relation, makes a small nest composed of several pieces of seaweed, the eggs being laid in the middle and the seaweed firmly secured by a thread wound round it which is exuded from the body of the male whilst he circles round the nest. This little fish is known as the Fifteen-spined Stickleback from the fifteen sharp spines it bears on its back behind its head. It is a few inches long, pointed at both head and tail with a long snout and is much more slender than the freshwater species. The nest, which is made by the male, is to be found in shallow water below the lowest tide mark, usually amongst the sea grass and other seaweeds that the fish frequents. About a hundred eggs are laid in the nest, pale yellow in colour, and each about two millimetres across. The baby fish which hatches from this egg has an enormous yolk sac in which there are numerous bloodvessels so that one of these examined alive under the microscope shows most beautifully the circulation of the blood and the individual blood corpuscles. The father fish is said to look after his young for some time after they are hatched.

Amongst other shore fishes we find that at least one of the Bullheads lies with its whole body over its eggs to protect them, and one of the Pipe-fishes (Fig. 5), which lives under stones between tide-marks, carries the eggs glued to the under-surface of its body. Many Pipe-fishes live among the seaweeds close to the shore in shallow water, the male always carrying the eggs, either exposed in a layer on the under-surface of the body or protected in a pouch; in the latter case the newly-hatched fishes are kept for some time in the father's pouch. The little Sea Horse occurring only very rarely in British waters also carries its eggs in a pouch.

From these examples we can see the varied breeding habits of the shore fishes, and that the majority of them protect their eggs in some way. This is a sharp contrast to the habits of most of the common fishes which swim about round our coasts. These almost entirely (if we except the Sharks, Skates and Rays which form a totally different group) shed their eggs into the sea singly but in enormous numbers, each egg usually floating in the sea and carried about by the water at the mercy of storms and waves and enemies of all kinds. On account, therefore, of all these vicissitudes these huge numbers of eggs must be formed, and it is easy to see why the shore fishes are able to do with much smaller numbers. One hundred eggs or less is an average number for many of the rock fishes; several million is not sufficient for many of the true open-sea fishes. Instances may be given of the Turbot which lays ten million to fourteen million eggs, the Sole 750,000 and the Cod over two million.

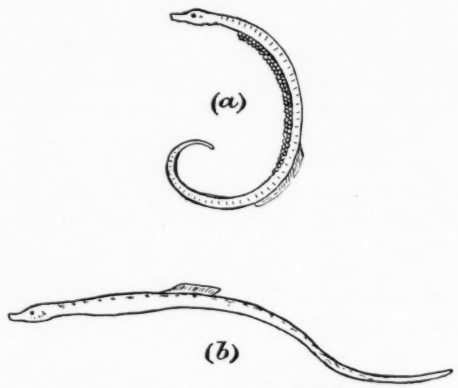


FIG. 5.—A MALE AND A FEMALE PIPEFISH.
(*a*) Male from beyond low-water, 10 inches long, carrying eggs; (*b*) Female from between tidemarks, 5 inches long.

DIESEL-ENGINED ships produce no steam. When they sound a siren in a traffic-crowded riverway it is not easy to see which ship is hooting as the customary cloud of steam is absent. A new invention applies a tank of liquid-stannous chloride (which produces smoke on contact with the atmosphere) to a compressed air siren. This provides a visible as well as an audible signal for Diesel-engined boats.

The Crowing of Pheasants.

By H. M. B.

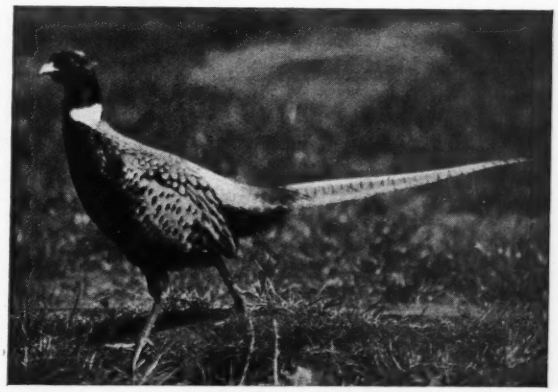
When pheasants were disturbed by aircraft it was held that they were responding to an old fear of giant predatory birds. Now it would seem that it is concussion, either air or earth wave which stimulates the alarm. They also appear sensitive to earth tremors. Our correspondent seeks information on other recorded cases.

SOUNDS often react in strange ways upon birds and animals, and it would seem that the cock pheasant is strangely susceptible to certain noises. It was observed during the war that pheasants were veritable barometers in foretelling the approach of heavy aircraft, and succeeding almost every Zeppelin raid and the aeroplane attack upon London there were comments in the Press from one quarter or another concerning the curious behaviour of pheasants. They seemed able to hear the approach of heavy air-craft long before the noise thereof was audible to human ears, and one case in particular comes to my memory, A Zeppelin flew over Norfolk, dropping some bombs. if I remember rightly, on Brancaster village, and it was stated that some time before the noise of the engines was detected by anyone the pheasants began to crow in an alarmed state, alighting upon the fence tops and flying from point to point.

Blasting Operations.

Under the peaceful conditions of to-day, the same strange characteristic is often noticeable in these birds. Not long ago some foresters were at work blasting up roots in a wood near the writer's home, and with the first shot, only just audible across the distance, a commotion began among the pheasants. Seemingly the sound caused a state of general agitation in the surrounding coverts, for some time after the birds could be heard crowing and apparently flying from place to place. Throughout the day the blasting continued at irregular intervals, but ere long the excitement died down. It was certainly not a case of the birds mistaking the blasting for the sound of a gun-shot. Gun-shots are of daily occurrence in the same woods, and I have never known a report of this kind to meet with any response. A year or so ago, however, there were some naval manœuvres off the coast perhaps 20 miles away, and the pheasants then behaved in just the same way as when the dynamiting occurred.

When some deep and powerful sound of this kind occurs after the fall of dusk, or, indeed, late at night, it often takes the pheasants a considerable time to calm down. Living in the Highlands, with hills all round, and the narrow glen well wooded, I was often struck by this. Some sound would set the pheasants going after darkness, those on one side of the glen being answered by their neighbours across the river, till, calling and answering, the whole valley would ring with their notes. Sometimes from quite a small beginning general excitement would follow. A cock pheasant gives the alarm, another answers, others join in the chorus, and so they seem to be flying and



THE ATTITUDE OF ALARM.

calling everywhere. Then the hubbub reaches its climax, subsides, grows again, and so on for possibly an hour or more. On still mild nights it sometimes goes on all night, and if we could find out the exact nature of the sounds which evidently jar upon the ear-drums of this bird, it might be possible to train a few cock pheasants to perform useful service as army or navy watchdogs ! H. M. B.

THE alcoholic fermentation of glucose generates gases. A residue of these gases has now been found to contain argon. As this is held to be an inert gas its detection in this connexion is engaging the attention of research chemists.

RAW meat diet has its advocates no less than vegetarianism. French biologists report that raw meat is indicated in the diet of those troubled with liver affections. Kidney troubles, on the other hand, benefit from a diet in which meat is decidedly over-cooked.

Immensities of Time and Space.

By A. Vibert Douglas, M.B.E., M.Sc.

The astro-physicist thinks in terms of millions of years. Can we ever tell the age of the starry universe, or estimate how long our own little solar system has existed. This article sets out in popular form some of the latest scientific thought on these problems.

WITHIN the last twelve months three workers in the realms of mathematical astronomy and cosmogony have brought their researches to conclusions of tremendous importance and widespread interest. So closely are their problems interwoven that it may prove stimulating to consider in some detail the aim of each investigation, the line of argument, and the outstanding results thus far achieved.

Star's Mass and Luminosity.

Last year there was given to the Royal Astronomical Society by Professor A. S. Eddington, F.R.S., a paper which has aroused great interest among astronomers the world over. For many years Professor Eddington has been investigating the radiative properties of a giant star, that is, a star of gigantic size and low density, so low that it could be considered as obeying what in physics are known as the "perfect gas" laws. These investigations led him to the conclusion that the total luminosity of such a star depended chiefly upon its mass and temperature, being almost uninfluenced by other factors. To test the validity of this formula relating luminosity to mass, he first evaluated the constants involved in it from the known values of mass and luminosity of the bright star, Capella. He then plotted his relation as shown in the accompanying graph by the curved line. Next he collected all the available data from every possible source, giving both the masses and luminosities of stars and these he plotted individually on his graph. Their close proximity to the theoretical curve is very striking, and forms a strong confirmation of the validity of the theoretical work.

Curiosity, we suppose, led him to wonder where the points would lie representing similar data for the dwarf stars. Now the dwarf stars were so named by Professor Henry Norris Russell because they are so dense, due to gradual contraction, that it was thought impossible that the gas laws could hold true in their case. Hence a relation between mass and luminosity explicitly based upon strict adherence to the gas laws, would not be expected to hold good for a star of the dwarf type. But, *mirabile visu*, the plotted points for data taken from dwarf stars conform as well to the theoretical curve as in the case of the giants.

This was an astounding fact suggesting as it did that the dwarf star, no matter what its density, was in the state of atomic agitation of a perfect gas. The explanation given by Eddington seems plausible, though it has not been accepted unanimously, namely that where matter is subject to such high temperatures as exist in the stars, temperatures to be measured in millions of degrees, each atom is reduced in effective volume a hundred thousand times since its revolving electrons, whose outermost orbits determine its normal effective volume, are all stripped off or ionized by the intensity of heat. Each electron is thus so filled with energy that it moves about as an independent unit unrestricted to any atomic orbit. Thus a free gaseous state can exist in spite of much closer packing than would suffice at ordinary temperatures to reduce the matter to the state of liquid or solid.

Dense Stars.

This conception, if it be true, throws light on a long standing astronomical mystery. There are known to be a few stars, like the *white dwarf* companion of Sirius, so small yet so massive that their density worked out to be of the order of fifty thousand times that of water—an absurdity it was thought, an impossible result, something radically wrong somewhere in the observations or calculations. But instead of finding something wrong with the calculations, Eddington's work suggests that the trouble lay in our thinking the result absurd, in our failure to realize the tremendous difference between the state of matter at terrestrial temperatures and at stellar temperatures.

Giants and Dwarfs.

If then all the stars are in a true gaseous condition, it is necessary to modify all ideas and calculations based on the old point of view that the dwarf stars were not obeying the same laws of pressure, volume and temperature as the giant stars. Professor H. N. Russell's famous Giant and Dwarf Theory of Stellar Evolution suggested that a star began its career as a very large mass of gas, highly inflated and much less dense than air. This would slowly contract by gravitational influence, growing hotter and hotter and brighter and brighter. This period would embrace its life as a giant star. When contraction had reached such a point that, upon the old view, the gas laws

could no longer be considered as even approximately representing the state of the star, then at this critical point of balance between mass, density and temperature, further gravitational contraction would of necessity be accompanied by decrease of temperature and of luminosity. This period constituted the dwarf stage of a star's career. Now this theory is thrown into a new light by Eddington's results. If the mass of a star be constant throughout its life, Eddington's formula shows that there can be very little alteration in luminosity in spite of contraction, and hence the evolution of a single star as outlined above is an

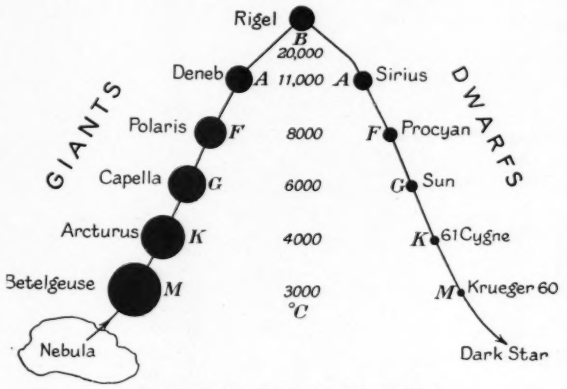


DIAGRAM OF STELLAR EVOLUTION.

impossibility. If as an alternative interpretation the mass of a star is gradually diminishing, being actually consumed away to maintain the supply of energy which a star is continuously radiating, then Russell's theory of evolution may be retained as indicating the probable sequence of stellar change, but with this difference that, though the effective or surface temperature may decrease during the latter stages, the internal temperature will continue to rise.

Loss of Mass.

A great deal thus turns on whether the mass of a radiating star can actually be considered to be diminishing. There are, furthermore, two ways of looking at this question.

One suggestion is that by collision of a very infrequent type between an electron and a proton (the ultimate particles of matter known to the physicist, carrying the unit electrical charges, negative and positive) their impact results in complete annihilation of their mass, that is, of the matter which they form, a definite amount of radiant energy being the equivalent result. This is highly speculative, there being no observed phenomenon in nature to prove definitely that such a transformation can take place; but it is theoretically possible, for matter and energy are essentially the same thing. Matter is one of many forms of energy and in the usual units of measurement of energy, the energy-equivalent of a mass m grams of matter is $m\,c^2$ ergs where c is the velocity of light 3×10^{10} cm. per sec. In other words one gram of matter represents a potential concentration of energy

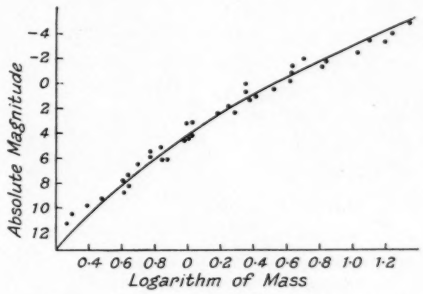


DIAGRAM OF LUMINOSITY-MASS RELATION.

equivalent to nine hundred million-million-million ergs, or as more conveniently expressed, 9×10^{20} ergs; or one pound of matter embodies $1\times(186{,}000\times5{,}280)^2$ foot pounds of energy, that is 10^{18} foot pounds.

The theory of relativity has shown mathematically, and it has been confirmed experimentally for fast moving alpha and beta particles, that what we term mass is really a property of matter that depends upon its velocity. Mass increases with increase of velocity, but this increase only becomes apparent when the velocity is so great that it becomes comparable to the velocity of light. The full expression for mass-energy in the relativity theory is

$$m\,c^2=m_o\,c^2+\tfrac{1}{2}\,m_o\,v^2+\tfrac{3}{8}\,m_o\,v^4/c^2 \quad +\text{———}$$

Here the first term is the whole intermolecular energy of the mass at rest; the second term is its kinetic energy, or the energy possessed by it in virtue of its motion; the third and subsequent terms will be quite negligible for small values of the velocity v of the mass, but become appreciable one by one as the velocity v approaches the velocity of light. From this it follows that in order for the mass of a star to diminish as a result (or perhaps we should say as the cause) of its radiation, it is not necessary to postulate the annihilation of matter, but simply the loss in mass resulting from loss in velocity. From the above equation it can be seen that this might well be a tremendous reservoir of available energy.

The idea that continued stellar radiation might imply gradual loss in stellar mass was not new. It had been suggested some years ago by Dr. J. H. Jeans,

but the facts above explained brought this idea forward with a new significance. Dr. Jeans saw that if this idea be really true, many astronomical problems are seen in a new light, and many investigations require reconsideration. This he has done and only recently has he published his results.

Age of Sun.

One of the questions which has provoked controversy between geologist, physicist and astronomer for many years is the probable age of the earth, an estimate of the age of the sun being, of course, an upper limit to the age of the solar system. Jeans attacks the problem from the new point of view, and his argument is as follows: The sun is radiating away its mass at the rate of about 4,200,000 tons per second and, if it were once as massive a star as Sirius snow is, then it has been radiating for 7×10^{12} years. This means an age of at least a million million years, and is several thousand times greater than any previous estimate—a figure so great that it baffles comprehension, and staggers even the imagination.

Galaxy Expanding.

There is an interesting consequence of loss by mass by radiation which has an important bearing upon our system and upon the galaxy of stars about us. If our sun be gradually diminishing in mass, the law of conservation of momentum requires that the planets move gradually off in ever expanding orbits. Similarly if the mass of our galaxy as a whole be gradually diminishing the stars must be opening out, spreading further apart from the common centre of gravity and therefore from one another. Jeans estimates that 10^{12} years ago this galaxy was packed sixty-four times more closely that it is as the present time.

Binary Stars.

This modifies various problems of cosmogony in a remarkable manner. The orbits of binary stars have long been a mystery because no mutual force between two such stars was known which could account for their being in such eccentric and large orbits about their common centre of gravity. Jeans points out that it is no longer necessary to look for such a force, that with the enlarged time-scale for the galaxy (greater than 10^{10} years) outside influences become not only possible but very highly probable, that is to say, the normal orbits of a binary system may be perturbed by the gravitational pull of a passing star approaching more closely than is usual. The chance of such an influence being brought to bear upon a binary is greatly increased by the closer packing of the system in bygone ages. Basing his calculations upon the observed percentage of decidedly modified binary orbits and the probability of outside influence, Jeans obtains an estimate of the age of the galaxy which confirms his previous result of 10^{12} years.

Mass and Velocity.

A statistical study of the masses and the velocities of stars revealed a striking correlation, which though incomplete pointed towards equipartition of energy. No satisfactory explanation of this was offered until Jeans dispelled the clouds of mystery by showing that it is essentially the same problem as that just discussed. The mutual influences of the stars, originally sixty-four times as closely packed as now, has resulted in the course of 10^{12} years in bringing some measure of order out of primeval disorder. It is analogous to the behaviour of a mixture of gases—if undisturbed by external influences the tendency would be for those molecules most massive to move most slowly while the lighter molecules moved with the greater speed, the kinetic energy or product of mass by velocity squared, tending to be the same for all the molecules. This also formed a basis, though of a truth a somewhat shaky basis, for again confirming the age of the galaxy as 10^{12} years.

Solar Systems.

The nebular hypothesis of Laplace and the planetesimal hypothesis of Chamberlin have gone into the history of science as great and lasting monuments to their originators both of whom were powerful and constructive thinkers. As a direct development from Chamberlin's hypothesis, Jeans some years ago worked out upon a rigorous mathematical basis his tidal theory of the origin of the solar system. In view of the contrast between his conclusions in 1919 and his present conclusions in the light of the researches under review, it is worth while to consider the tidal theory in some detail.

An analysis of the equilibrium forms of rotating fluids under various conditions amenable to mathematical treatment, revealed the fact that within a rotating gaseous mass there are no forces which could combine to produce a series of planets such as encircle our sun. Hence following the lead of Chamberlin, Jeans called in the aid of a passing star to supply the force necessary to disrupt the parent sun. It is obvious that a close approach of one star to another would draw out tides, one on each side of the star considered, the tidal arm on the side nearest to the tide-producing star being slightly the greater, and therefore more readily drawn out to a distance producing its instability. The matter in this arm would then break away from the parent sun and follow orbits about the sun in directions governed by the direction of travel of the passing star. Condensation would gradually take place about any

points in the tidal arm where there happened to be a local concentration of gas. Each of these nucleii would become one of the planets and its orbit, and other individual characteristics would be determined, in part at least, by the influence of the "resisting medium" through which it moved, this medium being composed of the vast millions of gaseous particles scattered hither and thither into space about the sun by the cataclysmic disruption of the tidal arm.

The formation of satellites by the planets is, again, an evidence of tidal action, but in this case the sun itself was the tide-producing agency which caused the disruption of the planets when each passed its perihelion for the first time. That some satellites so formed eventually became detached from their parent planets to be captured by other planets is one of the interesting results of the action of the resisting medium.

Dr. Harold Jeffreys has recently proposed several modifications of the above tidal theory. The outstanding point of difference is that Jeffreys limits the size of the ancestral sun to forty million kilometers in diameter, whereas Jeans had presupposed a much less dense sun of diameter eight thousand million kilometers; the former figure is approximately the diameter of Mercury's orbit, the latter figure is greater than the diameter of the orbit of Neptune. The evidence in favour of the smaller figure seems to be fairly strong.

Unknown Planets.

The point of interest in both these forms of the tidal theory is that they led to the belief that our solar system was possibly unique in the galaxy of stars, because the chance of two stars approaching closely enough to produce tidal disruption, namely 10^{10} kilometers, was only once in 10^{10} years, which was the whole age of the galaxy then considered possible. With the much greater time-scale now proposed by Jeans, and considering also the much closer packing in those early millions of years, the probability of the close approach of two stars becomes decidedly great. Hence the conclusion now reached by Jeans is that of the myriad stars we see about us—not the majority—but a considerable number are probably suns to a family of planets. Like our own solar system in many respects, these numerous other systems may be, yet differing probably from it and from one another in all the details. Whether upon some favoured planets in some of these many systems there have been developed physical conditions as on this earth, rendering them fit cradles for the advent of life we know not, and it is beyond the scope of the mathematical physicist and astronomer to speculate further.

Stability of Galaxy.

An investigation of very great interest has been carried out during the last year by Dr. Ludvik Silberstein on the question of the permanence of star clusters, in particular, the great star cluster or galaxy near the centre of which our solar system finds itself. Silberstein bases his calculations upon the four-dimensional spacetime relations of de Sitter, and from this starting-point he last year deduced a relation which could be evaluated in terms of observed astronomical data in such a way as to give a numerical value for an invariant characteristic of spacetime called by the mathematician the radius of curvature. This quantity, symbolized by R, has the finite value of 10^{12} astronomical units, that is 10^{12} times the distance from earth to sun. This theory, with the consequent value of R, has not been universally accepted, but this does not detract from the interest of the subsequent reasoning by which Silberstein deduces a criterion of stability in terms of the total mass of a system of material bodies (molecules or stars) and the radius of the system. Associated with any given mass there is a critical distance. If a star be at a greater distance than this critical value from the centre of gravity, its orbit will of necessity be a hyperbola. This means that sooner or later it will desert the system for ever. On the other hand if its distance from the mass centre be less than the critical value it will describe an elliptic orbit thus remaining indefinitely within the system.

We Cannot Last.

This criterion has been applied to those globular clusters far out in space beyond our own galaxy, for which the astronomer has been able to form estimates of their size and mass. They are found to be considerably less massive than our galaxy and very much more closely packed, so closely packed that the calculated critical radius is much greater than the dimensions of the clusters, which may, therefore, from the point of view of this theory, be considered as stable aggregates of stars.

The reverse is the case of our own galaxy. Much too widely scattered for its mass, its radius exceeds the critical value for stability, and therefore this theory predicts that it will suffer from what Dr. Silbertsein terms "hyperbolic desertion" until its ranks be reduced and its volume diminished to such an extent that the criterion might perchance be satisfied. In its present form it is, like the Roman Empire, far too inflated to be enduring.

Densities can be treated in a similar manner. Silberstein evaluates the critical density of matter in

space in terms of his finite curvature invariant R, the gravitational constant and the velocity of light—three fundamental quantities in this complex universe. Any aggregation of matter of less than this critical density will be unstable and tend to dissipate, whereas any aggregation of density exceeding this value will be in a state of stability. The galaxy of stars in which our system finds itself is estimated to have a density fifty-two times too small to satisfy the conditions for permanence.

No Solution Yet.

Having surveyed the future, let us, in the light of this same theory, glance backward in an endeavour to trace the origin of a stellar cluster. Silberstein considers the possibility of a gaseous mass or nebula giving rise to millions of individual concentrations of matter, and thus forming the individual stars of a cluster. This was essentially the primary postulate of Laplace, though he was considering the relatively minute case of a nebula giving rise to a solar system—an impossible hypothesis in the light of modern knowledge. But as an explanation of the evolution of a small galaxy of stars, like many of the star clusters revealed by the telescope, it is by no means to be discarded—it may well be the true solution of the problem, as was pointed out by Jeans some years ago. When, however, an attempt is made to explain the origin of our galaxy in this manner, it is found to be incapable of satisfying all the conditions. Our galaxy, to quote yet another analogy taken by Dr. Silberstein from the history of mankind, must have developed, like the far-flung British Empire, by the aggregation into one conglomerate whole of many remnants of previous systems, systems long since scattered to the four winds.

Guided by some of the great thinkers of to-day our thoughts have traversed aeons of time, contemplating some of the changes taking place with majestic deliberation throughout the vastnesses of space. "Time rolls his ceaseless course." A million million years suffice for the birth of a star and its early development; a few hundred thousand years will tell the tale of the life of mankind upon this planet; and as for man, an individual man, the years of his life are three score years and ten, and yet such is the power of a great mind that, despite the brevity of its allotted span, it can wrestle with the problems of nature and learn something at least of the immensities of space and time.

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AGEING OF DOCUMENTS WITH TEA.

CRIMINALS are not often so thorough in their work as to discolour the paper of forged documents, when these are supposed to be some years old. Such an instance, however, has recently come to light. An analyst's suspicions were roused by what appeared to be brush marks on a yellowed paper. Chemical analysis revealed that the paper had been brushed with a weak infusion of tea to give it the age corresponding to the forged date.

ELECTRIFICATION OF SICILIAN SULPHUR MINES.

ATHOUGH the Sicilian sulphur industry is not organized on so large a scale as that of the southern states of the U.S.A., yet it is the oldest in the world and occupies no less an area than one-fifth of the total island and employs 20,000 workers.

Possibly because of its antiquity, modern methods have not been adopted in the industry. Lack of cheap power may also have prevented up-to-date development. Rapid expansion is, however, anticipated in the near future in consequence of the proposed erection of electrical generating stations on the island. These are designed to develop electrical current at a price that will be attractive to the sulphur industry. With electrification other improvements will follow and the Sicilian industry may be expected soon to rival Louisiana in the excellence of its equipment and organization.

THE TAUNG'S SKULL.

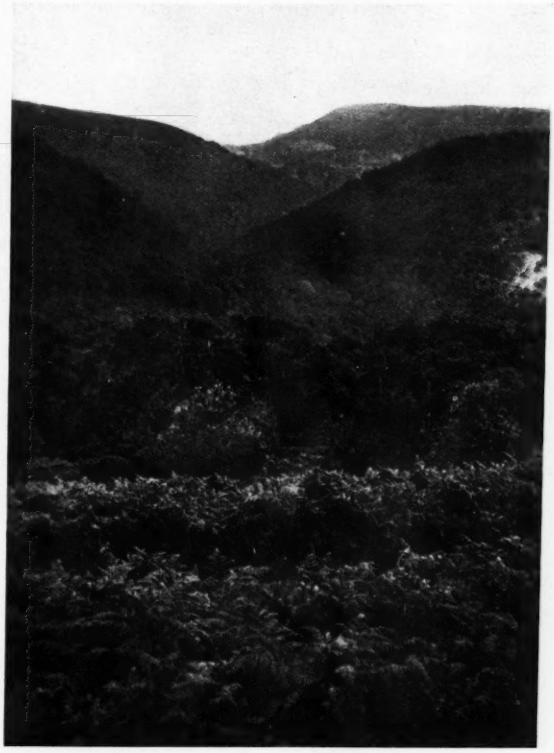
SINCE the arrival of plaster casts of this skull from South Africa there has been a considerable modification of scientific opinion. It is now held on good authority to be purely ape and not necessarily related to a man-ape. The discovery has thrown light on the history and distribution of anthropoids, but the human relationship is vigorously disputed.

Wild Red Deer at Exmoor.

By E. W. Hendy (Ernest Blake).

We are accustomed to look on the fox and the badger as our largest wild mammals. Yet on Exmoor we still have the wild red deer and plenty of them. We owe their existence to the hunting. Long may it flourish.

Most people who come to Exmoor travel by way of Minehead, whether the journey be made by rail or car. Thence the way lies by road to Porlock. It is at the top of the hill known as Venniford Steep that you get your first sight of the distant moors. In a broad sweep from left to right a rampart of hills (an eighteenth-century writer would have called them "mountains") encloses the lovely vale of Porlock. The bare bleakness of their summits is relieved by the leafy beauty of the coombes which burrow into their sides and, near at hand, by the "bosomed woods" of Selworthy. Here you are at what has been called "the Gate of Exmoor"; but it is only the gate. If you are bound for Brendon or Lynton another half hour's drive brings you up the famous Porlock Hill to Oare Post, and there, like Jack when he climbed the beanstalk, you are in a new land; and what a land it is! For mile after mile the delighted eye roams over wide stretches of rolling moorland, in August incarnadined with purple ling and glowing



CLOUTSHAM WOODS WHERE THE WILD RED DEER BREED.
[*Copyright Alfred Vowles, Minehead.*

The Great Moor.

with the deep green of waving fern. Seen thus the moor seems level or, at the most, undulating, but look closer and you will see that it is really seamed throughout by deep delved coombes. Richard Jefferies found the "open distances" "oppressive"; he felt "the awful homeless spaces scare his soul." But to others these limitless horizons bring a sense of freedom and unburdening; theirs is the mystical spell of the infinite unknown; they hold the springs of wonder and romance.

Before you reached Venniford Steep you were well into the red deer country. Deer are hunted in the Quantocks, and Perriton Combe and Tivington Plantation, just on your left, are full of them. Exmoor is the only region of England in which red deer have roamed wild from prehistoric times to the present day. That this is so is due to several causes. Exmoor was, until the days of motor cars, very inaccessible;

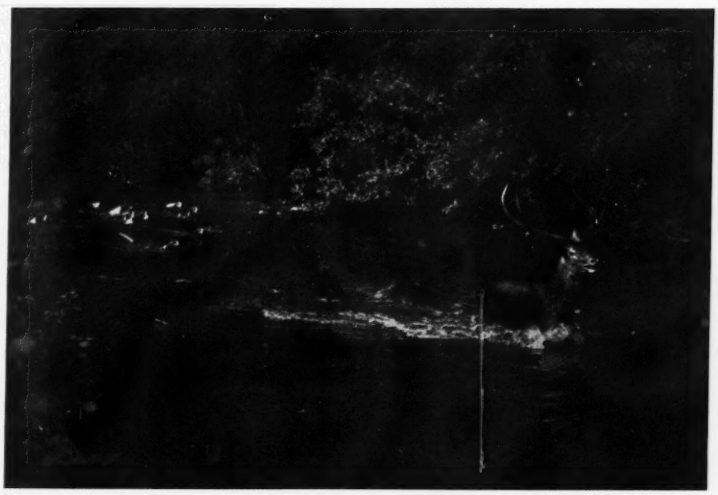
Isolation.

even now there are, fortunately, many parts of it to which the char-a-banc cannot penetrate. Then again, much of it consists of land unsuitable for any but sheep farming. And, in addition, varying portions of it were, from Saxon times till about one hundred years ago, a royal forest. This forest (which never contained many trees) did not, of course, include all of what is now loosely called "Exmoor." When disafforested and enclosed between the years 1815 and 1819, it contained only 20,122 acres, which lay, speaking roughly, within an irregular triangle whose three corners were Alderman's Barrow, Willingford (about mid-way between Withypool and Molland) and Saddlegate (not far from Challacombe); but, at one time, its boundaries had extended much further.

attacked. Before you sit down under a beech hedge to eat your sandwiches, make sure you have not chosen the spot which an adder has selected for a sun bath. An ample lady once sat upon one by accident; asked afterwards to describe the reptile, she said it was flat; but only welter-weights can do these things with impunity. Should you be bitten, open the wound and apply permanganate of potash (I always carry some with me), tie a ligature above it, drink as much whisky as you can beg or borrow, and seek the nearest doctor.

Tracking the Game.

Of the mysteries of "slotting" (*i.e.*, tracking the deer by its slots or footmarks) there is not space to write. I will only give one hint: find a soiling pool, and spend a half-hour examining and even measuring the slots of the deer round it. Make notes of the results, and verify them by the information to be found in any good book on stag hunting; you will thus learn much—but not all—of an art upon which many learned and interesting pages have been written.



A WILD DEER TAKING WATER IN ANTHONY'S WEIR ON THE SOMERSET SIDE.
[*Copyright Alfred Vowles, Minehead*

The stags dropped their old antlers in the spring; by August their new ones have grown, but they are probably still covered with the remains of that marvellous network of blood vessels which is known as the "velvet"; this they rub off against trees: search almost any larch or fir covert where deer are plentiful, and you will find saplings whose bark has been stripped for some feet from the ground by the friction involved in this process; careful scrutiny may show some of the stag's hairs still adhering to the trees. The hinds cast their calves in June, and now have them running with them. Both stags and hinds at this period keep pretty much under cover either of wood or fern during the day; the best time to see them is either at early morning or late evening. But, if you sit down, concealed as much as possible, near or in some coombe which local knowledge or your own experience tells you is favoured by deer, you will, if you have patience and keep quiet, be unlucky if you do not eventually catch at any rate a glimpse of your unhunted quarry. Do not expect to see them soon, and be prepared for disappointments: the patch below the stunted oaks looks very like a deer, but it is only red earth; the tawny fleck in the midst of a field of fern is merely a piece of early-faded bracken; dead gorse stems look surprisingly like branching antlers, and even the yellow bloom of the same bush, when on the wane, looks curiously tawny in the distance. But, after a while, you will see a russet something deep down among the rowans, which is certainly in motion; there is a flicker, and your field-glasses show you that it is a hind twitching her ears; she is reaching out her long neck to nibble at the young rowan shoots. She moves forward, and now you can see the whole of her beautiful tawny body, and there, behind her, are two others. They feed quietly for a little until they get your wind and then, after eyeing you for a few moments, they disappear, with a curious coughing grunt. This is the hind's alarm signal; probably there is a calf about but, in the thick undergrowth, you are not likely to catch a glimpse of it.

The Stag's Esquire.

Silence again for a while, except for the rustle of the wind over the heather and in the leaves, and the rise and fall of the brook's chatter, borne intermittently on the breeze from the depths of the coombe below. Then, suddenly, another head crops up, there among the thickest gorse; your heart leaps as your glasses reveal antlers, but no, it is not a full-grown stag; only a young male deer with two straight "spires" or uprights, and short brow antlers. Still, there is no need to be disappointed. An old stag often has a young attendant—his esquire—in his company; when disturbed he puts up this *corpus vile* to attract the attention of the interloper, human or canine, while he himself lies low in cover, with head out-

And, last but not least, the wild red deer owe their existence to stag hunting. Saxon, Dane and Norman were all mighty hunters. Under the last-named, the cruel and oppressive forest laws were sternly enforced on Exmoor; there are records in the Forest Pleas of fines and other punishments inflicted upon poachers and trespassers. A list of the wardens of the forest from 1508 to 1642 is extant, and there is a sturdy tradition that staghounds were kept at Simonsbath as long ago as 1598. In the latter half of the seventeenth and the first half of the eighteenth centuries the stag hunting records are fragmentary, but from 1746 onwards its annals are well known. In 1825, just one hundred years ago, the old pack was sold, and thereafter came lawless days when, for many years, no regular pack was in existence; poaching was rife, and the deer were shot and slaughtered in and out of season until they were almost exterminated. That they survived at all is due chiefly to the enthusiasm of the famous Mr. Bisset, who re-established the pack on a secure basis in 1855. By that time, according to contemporary estimates, there were only some sixty deer left on Exmoor. To-day there is luckily no fear of their extinction.

THE HOMER VALLEY, FROM CLOUTSHAM.
Hunting opens with the mid-August Meet at Cloutsham Farm.
[*Copyright, Alfred Vowles, Minehead*

How to Follow on Foot.

It is not my intention in this short article to treat of red deer from the hunting point of view. This has already been done by many who are eminently qualified to do so. I will only say that those who, like myself, occasionally follow on foot, can, if they wish, see plenty of sport. They will, however, be wise to follow the example of Theseus and Hippolyta (in "A Midsummer Night's Dream"):—

"We will, fair queen, up to the mountain's top,
And mark the musical confusion
Of hounds and echo in conjunction."

Seek, say, the summit of Dunkery Beacon, and you will, if you have a fair knowledge of the country, and enough energy left to make when necessary a circumbendibus in the direction of Rowbarrow or Robin Howe, see as much of the hunting as the mounted people who do not believe in over exertion. Or, if hounds are meeting "out over," all you need to do is to sit on Black Barrow and revolve slowly on your own axis. Of course, if you want to see a kill, you will almost certainly have to come down to water; but if you do so, remember

"Facilis descensus Averni:
Sed revocare gradum, superasque evadere ad auras,
Hoc opus, hic labor est."

In other words, the sides of most Exmoor coombes are steeper than they look.

Watching.

But if you desire to see something of the red deer not only when "heated in the chase" but at peace and following their natural inclinations, these "few precepts" may be of use. First, the more quiet you are the better your chance of seeing deer. Chatterboxes see nothing, and deserve to do so. White shoes and stockings, though no doubt admirable for the sea front at Minehead, are not the ideal "footwear" (excruciating word) for the moors. The prevailing colour of Exmoor earth is red, and peat bogs are black; it is wise to choose clothing which, in its pristine state, assimilates, to a certain extent, with this environment. Otherwise nature is prone to give one a brutally frank lesson in protective colouration. Again, there are few seasons when the wind does not blow on Exmoor, and when it does it is cold, even in the torrid days of June. Also there are adders; it is inadvisable to step on one, or to pick one up in mistake for a grass snake; like Cuvier's rhinoceros, the adder is a vicious animal and defends itself when

stretched and antlers thrown back. Perhaps this youngster is such a companion. It is worth while, if nothing else happens after a quarter of an hour, to descend into the coombe, and see if you can rouse a big deer. The esquire and the hinds will not wait for you; you will hear them go crashing through the scrub long before you get a view of them. As like as not his lordship will not move. But if, as you retire hot, thirsty and disconsolate, you chance to look back, you may catch sight of him standing with head and antlers thrown back, snuffing the air, and regarding you contemptuously.

One August many years ago I and a companion made a most successful stalk. Walking up one side of a coombe beyond Cloutsham, we espied three stags crouched in heather on the opposite slope. To approach them down wind was, of course, useless, but by making a circuit of some half-a-mile we recovered the wind of them, and crawled on our stomachs over the heather to within thirty yards of our quarry. To our delight there turned out to be two other stags lying just below. The largest of the five was a magnificent fellow, with the finest spread of antlers I have ever seen; he had all his rights—*i.e.*, brow, bay and tray antlers, and four points on each side—eight on top; of the others, three had four points on top and the remaining one three. We lay there and watched them—utterly unconscious of our presence—for many minutes. When at last we roused them, they galloped off to the nearest plantation with that marvellous springy, action which makes one wonder whether their legs are not composed of superfine elastic and steel springs. You do not often get luck like that, at any rate in summer. Once, in winter, five stags trotted past me at a distance of about forty yards while I was sitting on a stump consuming a frugal sandwich, but at that season stags are less wary. They know well enough that they are not being hunted.

There can be little doubt that to-day it is hunting which preserves the wild red deer from extinction. When one has seen something of the damage which they do to farmers' crops, it is not difficult to realize that if hunting was abolished their doom would be sealed, and that in a few years. And it is only the fine sporting spirit of the countryside which makes hunting possible; one cannot speak too often of the debt of gratitude which nature lovers owe to local sportsmen of all classes. As a farmer once said to me, "A man is not thought much of down here if he shoots a deer." It is true that if the deer were not hunted it might be possible to preserve some of the herd in a private park; but, in these days of heavy and increasing death duties, landowners are not anxious to add to their expenses. And what are tame deer in comparison with the splendid wild creatures which have ranged free and untrammelled over the heathery wastes and grassy bogs of Exmoor for a thousand years and longer? One day last November I watched an Exmoor stag in Horner; there was "pride in his port, defiance in his eye"; two days later I saw a tame stag almost run over by a motor car in Richmond Park! Surely anyone who loves the wild life which is still spared to us here, where the octopus of industrialism day by day stretches its hideous tentacles further into the country, would prefer to see the red deer hunted and free, rather than unmolested and confined within park palings.

SALE PRICES CURRENT.

THE following prices were realized for scientific instruments at a sale at Steven's Auction Rooms on 26 June. The sale included much up-to-date apparatus in good condition, and the prices afford an indication of the very low figure at which it is advisable to value such material for probate or similar purposes.

A Koristka Model A2 full-size microscope with extra large tube, 50 m/m diameter, for all classes of work, and especially for use in photomicrography, diagonal rack and pinion coarse, micrometer side-screw fine focussing, quadruple nosepiece, revolving mechanical stage with verniers, rack and pinion sub-stage, Abbé condenser NA 1.40, eyepieces 4 and 12, No. 6 micrometer, No. 8 positive compensating, apochromatic objectives 16 m/m., 8 m/m. and 4 m/m. This lot, in case, etc., fetched £16.

A binocular microscope, with four eyepieces and two objectives 1 in. and 1¼ in. in case, polariscope and revolving stage, £4.

Dark-ground illuminator by Koristka, in case, 10*s*. A similar illuminator by Leitz, in case, £1 6*s*. Abbé drawing apparatus, £1 10*s*. Polariser and analyser, Beck, 10*s*. Gifford eyepieces by Baker, 6 m/m, 5*s*.; 9 m/m, 8*s*.; 19 m/m, 8*s*. Compensating eyepiece by Reichert, 12 × 5*s*. Projection eyepiece by Watson, 10*s*. An F 4.5 micro-summar by Leitz, 10*s*. Aldis F 6.5 2 in. objective, 15*s*. Half-plate vertical micrographic camera by Leitz, dark slides, focussing glasses, etc., £1 10*s*. A Cathcart microtome, slide-ringing turntable by Baker, and an electric micro lamp, 10*s*. the lot. An eight-day Admiralty meteorological station recording thermograph, 0°-110° F. by Darton, £2.

A number of microscope objectives of relatively modern construction and by good makers, ranging from 3 in. to ⅛ in. dry, fetched an average of eleven shillings apiece.

Worms as Friends and Foes

By Dr. H. A. Baylis, M.A., D.Sc.
Department of Zoology, British Museum (Natural History).

The influence of worms upon human activities in general is remarkable. Little by little science is exploring the relationships existing between tropical and other diseases of man and cattle and devising methods of destroying parasite infections.

We do not, perhaps, often look upon such lowly organisms as worms in the light of friends. Yet among the large and heterogeneous assemblage of creatures commonly called "worms" there are at least a few that seem to merit the term. Darwin, in his book on the formation of vegetable mould, made out a very convincing case in favour of the earthworms, the most familiar of all worms to most of us. He showed how, by continually enriching the soil with the remains of the vegetable débris upon which they feed, and by constantly bringing up earth from below on to the surface of the ground, where it is exposed to the action of wind, sun and rain, they are the best of gardeners and cultivators of the land. Instead of regarding them as pests because they sometimes make our lawns unsightly, we should encourage them because of their beneficial effect upon the fertility of the soil.

In comparatively civilized countries worms have not found favour as an article of food, though oysters, snails and frogs are not despised. But in various islands of the Pacific certain marine worms are held in great esteem as delicacies, and are collected in large numbers by the natives. It is said that in Italy men employed in cleaning fish sometimes eat, in a raw state, the larval stage of a tapeworm, *Ligula*, which is frequently found in fishes, and consider it a welcome dainty. Even fastidious Europeans do not disdain to make use of worms as a means to the end of obtaining food. The worms that dwell on the seashore, no less than the earthworms of the garden, are favourite baits with fishermen of all denominations. And who can say how many earthworms go to the fattening of our poultry and of the woodcock, snipe and other wildfowl in which man delights?

Parasites of our Animals.

Among the tiny free-living threadworms, or Nematodes, there are some that attack the roots, bulbs or stems of cultivated plants and cause, or help to produce, various diseases of our crops. But there are others that prey upon the former, and so unconsciously play the part of friends of man. It has been suggested in America that these predaceous forms should be cultivated and pitted against the pests, as the parasites of various insect plagues are already cultivated or encouraged.

It may be that as our knowledge increases we shall discover more instances of worms acting as our friends. At present it is certainly easier to find examples of worms in the capacity of foes. In the first place, one naturally thinks of those which are parasites of man himself. Man has a list of over one hundred and thirty supposed different kinds of worm parasites to his credit. Of these probably a considerable number have been erroneously identified, while many more have been added to the list on the strength of a single record due to an accidental infection with a species proper to some other animal. In fact, very few indeed of man's parasites are peculiar to man himself. Almost all are common to one or other of his domestic animals.

Few Real Dangers.

It is customary to regard parasites as necessarily foes. Naturally, we civilized people do not like the idea of harbouring uninvited guests, and probably through a long period of relative freedom from them we are more sensitive to their effects than are more primitive peoples. It is said that a native of Abyssinia considers his state of health abnormal if he is free from tapeworms. However, it is probably true that only a very small proportion of man's parasites are capable of causing serious harm to their host, unless present in exceptionally large numbers. Only some seven or eight species are, in themselves, a real enough menace to health, and of sufficiently common occurrence, to be regarded seriously as foes. Among these first place must be given to the hookworms. These are so important a factor in human life in warm countries that the International Health Board of the Rockefeller Foundation has spent, during the last twelve years, some four million dollars upon campaigns against them.

Three species of hookworms (*Ancylostoma duodenale*, *A. braziliense* and *Necator americanus*) occur in man. They are the cause, directly or indirectly, of a great deal of anaemia and general weakness and indolence

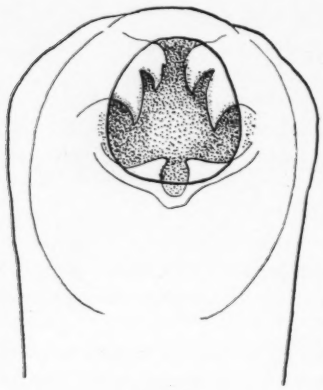


FIG. 1.
MOUTH OF THE HOOKWORM
showing the formidable teeth of the creature (magnified).

among the inhabitants of tropical and sub-tropical countries. They stunt the growth and development, physical, mental and moral, of children and adolescents, and sap the vitality of grown men and women. On tea, coffee and rubber plantations in India and elsewhere, the output and efficiency of work by the coolies have been enormously increased where steps have been taken to stop the ravages of hookworms. The outstanding feature in the life-history of these worms, which gives the necessary direction to modern measures for controlling them, was discovered by Looss at Cairo in 1898. He found that the larvae, which swarm on ground polluted by human excreta, have the power of penetrating the skin of persons coming into contact with them. An alternative mode of infection, which had hitherto been supposed to be the only one, is by the mouth. Even in this case, however, it appears that the habit of burrowing asserts itself and the larvae, instead of being simply swallowed, proceed to penetrate the mucous membrane of the mouth. After a complex course of migration within the body, during which they make use of the mechanical force of the blood-stream, and spend some time also in the lungs, the larvae finally reach the intestine, where they grow to maturity. The intensive hookworm campaigns now being carried on in many parts of the world aim at the medicinal treatment of all infected persons to remove the hookworms, and at the same time at providing, and educating the population to use, simple but effective sanitary arrangements, so as to prevent widespread infection in the future.

A Dangerous Species.

Another group of worms, containing three species that attack man, is that of the blood-flukes, or Schistosomes, which are also commonly known as *Bilharzia*. The adult forms of these worms live in the blood-vessels of their host, their eggs escaping by rupture of the walls of the small vessels, and reaching the exterior by way of the alimentary canal in the case of two species, or by way of the urinary passages in the case of the third. The eggs are provided with a spine, and it is to the occlusion by them of the small blood-vessels, and their subsequent rupture, with hæmorrhage, that the ill effects of the worms are chiefly due. Secondary sequels, however, such as bacterial invasions, the formation of vesical calculi, and even the production of cancerous growths, may be laid to the charge of the Schistosomes.

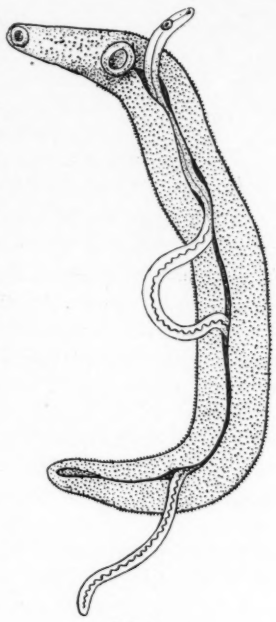


FIG. 2.
A PAIR OF SCHISTOSOMES.
The male carries the more slender female in a groove in his body (much magnified).

Meat Worms.

Their control depends chiefly upon the fact, now well-established, that the larval stages are passed in certain fresh-water snails. By the destruction of these snails the incidence of infection can be materially diminished, and may, it is to be hoped, ultimately be wholly suppressed.

The small worm known as *Trichinella* was at one time a much more serious trouble to man that it is at the present day, though even now epidemics of " trichinosis " are occasionally heard of. The ravages of this worm have been largely stopped by a rigorous system of meat-inspection. The three principal hosts of the worm are man, the pig and the rat, in all of which it can complete its entire life-history. Human infection is chiefly acquired by the consumption of imperfectly-cooked pork, the flesh of pigs not infrequently containing the microscopic cysts of the larval stage of *Trichinella*. It is in this stage that the parasite is most formidable, for the cysts are situated within the muscle-fibres and, when present in millions, cause extensive degeneration of the muscles, especially in certain situations, such as the diaphragm. By paralysing this important organ they may cause death from suffocation. In certain centres in Europe, where very large numbers of pigs' carcases have to be inspected before being passed as fit for food, an ingenious apparatus is now in use whereby, instead of having to examine every sample by direct microscopy, the inspector sees its greatly magnified image thrown upon a screen.

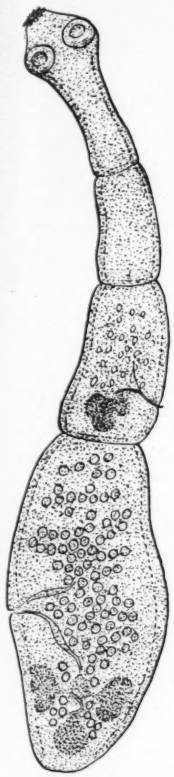


FIG. 3.
ECHINOCOCCUS.
Adult form from the dog (much magnified).

Among the tapeworms the most serious for man is one which, in its adult stage, is a parasite of the dog, and which is known as *Echinococcus*. It is the larval stage of this form that develops into the large cysts, called hydatids, sometimes found in the liver and other organs of man, besides occurring in various other animals, including cattle, sheep and pigs. When cysts of this kind occur in accessible places, they are generally removed by operation. Sometimes they occur in the brain, in which case they are generally fatal. In any case, the removal of hydatids must be accomplished with great skill, or there is danger of rupturing the cyst, and numerous new cysts may then form in various parts of the body. Sheep-dogs, or other dogs which have access to offal from slaughtered animals, are the most likely to be infected with *Echinococcus*, but it is advisable to bear in mind that some risk is involved in close association with dogs of any kind, and especially in allowing them near food intended for human use. The adult form of *Echinococcus* is very small, and its presence in a dog can only be diagnosed microscopically.

Besides worms which appear to be directly responsible for human disease there are, of course, several which are thought to be factors indirectly in the production of diseases. Among these are the threadworms of the *Filaria* group, whose embryos circulate in the blood-vessels and lymphatic system, and are believed to be at least partly responsible for the prevalence, in tropical countries, of that terrible and disfiguring disease, elephantiasis. There is now a growing suspicion, amounting almost to certainty in some cases, that among the predisposing causes of certain forms of cancer is the presence of worm parasites which in themselves, perhaps, are comparatively innocuous.

Farmers' Follies.

Next in importance, as foes, to man's own parasites come those of his domestic animals. Of these, of course, there are far more, for almost every kind of animal has a list of its own. Here again, there is reason for believing that the great majority are fairly

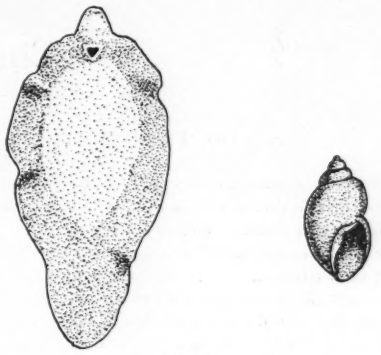


FIG. 4.
THE LIVER-FLUKE
and its intermediate host *Limnea truncatula* (much magnified).

harmless, but overcrowding and the unhygienic conditions which are too often imposed upon animals lead, frequently, to intensive contamination of pastures, pens and farmyards with infective material, with the result that abnormally heavy infections are acquired. Young animals especially are subject to parasitic diseases. Lack of proper attention to cleanliness is almost invariably the cause of such troubles. It is a prevalent idea, for example, that the pig is essentially an animal of filthy habits. Hence he is not given a chance of living in a clean pen, and when whole litters of little pigs die from pneumonia, as the result of mass invasions by the larvae of *Ascaris*, their loss is usually put down to some error in diet, or to the weather, or to anything but the real cause. This is the mud and filth by which they are surrounded, and with which their mother was covered. This filth swarms with the eggs of past generations of worms, and these eggs can live and remain infective for five years and perhaps longer.

When his sheep die from liver-rot, many a farmer will shrug his shoulders and say "It can't be helped—it is the fault of the wet season." In a sense he is right, but if the life-history of the liver-fluke and its connexion with wet seasons are explained to him he will probably be politely incredulous. That the sickness of his sheep has anything to do with the little snails that multiply on marshy pastures in wet summers (*Limnaea truncatula*, the intermediate host of the liver-fluke) is rather too much for his imagination. Yet if he had moved his sheep on to higher and drier ground for a time, excessive contamination of the ground, and excessive infection of the snails, could have been prevented, and in this way the heavy infection of the sheep would also have been avoided.

Until it is more generally realized that cleanliness is as necessary for animals as for man, parasites like these will continue to take their toll.

Correspondence.

To the Editor of DISCOVERY.

DEAR SIR,

I am sorry I have misunderstood Mrs. Erskine's statements, though I still do not see how her statements on p. 96 are reconcilable with complete validity of her theory. However, whether she admits no failures or a definite percentage, she cannot expect to convince men of science without laying her data before them in the accepted manner customary in scientific books or journals. I do not understand what she means by her qualification "when the mother is normal." Her theory is so simple that there should be no exceptions. Does she believe that in "abnormal" women the two ovaries are *not* different in sex-producing capacities? And what is her criterion of normality? It is, of course, easy to obtain 100% correspondence between theory and fact if all cases that do not show this correspondence are classed as "abnormal." If she is referring to her so-called "freak ovaries" (chap. 12) I can only say that after careful reading of her chapter I have found no evidence therein brought forward that the explanation of the facts is as she states it, and not merely an *ad hoc* "explanation" to account for cases which will not otherwise fit her theory.

As an example of Mrs. Erskine's method I may quote the conclusion of her chapter 12 (p. 105): "It is only right to acknowledge that, in the researches which have enabled me to fathom the complex problem of the 'freak' ovary, my best friend has often been my sex. It takes a thief to catch a thief; it required the intuitive brain of a woman to understand another woman, and to investigate with success the most capricious of her organs." Mrs. Erskine has apparently yet to learn that intuitions may (or may not!) be correct, but that their correctness can only be proved to the individual by the laborious process of verification, and to the world at large by verification plus publication of the verificatory evidence.

With regard to the "testimonials from biologists from all parts of the world," I can only say that I disagree with them when they assert that there is nothing in Mrs. Erskine's view contrary to "hitherto acquired knowledge of scientific fact." There *is* a perfectly definite *prima facie* contradiction between Mrs. Erskine's views and the current biological views. I pointed out in my article in your July number how a possible reconciliation between the two views might be effected, but pointed out also that the reconciliation would be difficult.

Finally, as evidence of Mrs. Erskine's acquaintance with other aspects of the problem of sex and heredity, I need only refer to the sentence in her letter where she states that the theories of Mendel are "based on the not over-reliable evidence of the microscope." Histologists and cytologists may be pardoned for resenting this unjustified slur on the microscope; but this we need not consider since, of course, Mendelian theories do not rest in the least upon microscopical evidence, but only upon breeding tests. It is only the chromosome theory of Mendelism which has to call in the microscope; the Mendelian facts stand whether or no the chromosome theory is true or not.

Mrs. Erskine's theory may be perfectly true. This does not prevent her book from being what I described it—"scientifically worthless."

Yours truly,

J. S. HUXLEY.

To the Editor of DISCOVERY.

SIR,

My attention has been called to a review in your July number by Mr. Julian Huxley of my book "Sex at Choice," in which is propounded a theory for pre-determination of sex.

I am aware that my discovery must meet with some antagonism from the disciples of Mendel, but I believe that the gulf between the theories of Mendelism—based on the not over-reliable evidence of the microscope—and mine, the fruit of twenty-five years of specialized labour and clinical experience, may yet be spanned.

Mr. Huxley, in his criticism of my work, is under a most grave misconception (and I can hardly believe that he has done more than peruse my book) when he asserts that I admit that "twenty per cent. of my cases are failures." *I admit none.* Probably he is referring to page 96 of the volume, relating to first children. Had I evidence of the failure of one single case out of the thousands that have passed through my hands during these past twenty-five years, where the mother was normal and the conditions of my formula had been adhered to, I should never have had the temerity to lay my work before the public.

I should like to add that I have received testimonials from biologists from all parts of the world who affirm that there is nothing in my discovery that is contrary to the hitherto acquired knowledge of scientific facts.

Yours very truly,

CICELY ERSKINE.

7 Eccleston Square, S.W.1. (MRS. MONTEITH ERSKINE.)

To the Editor of DISCOVERY,

"The Origin of the Maya Culture."

SIR,

In his letter in your July number criticising my article on the origin of the Maya culture, I note that Professor Elliot Smith is still convinced that the sculpture on Stela B. at Copan is intended for an elephant's head, and that many people to whom he has shown representations of it "scorn as absurd" the idea that it can be anything else.

It would be interesting to know whether those who agree with him were shown actual photographs of the sculpture in question (and photographs, moreover, from different angles), or merely drawings or diagrams made from photographs. In various books on this subject, I myself have seen many drawings purporting to represent this sculpture which, to anyone unacquainted with a good photograph, might well give the impression that an elephant's head was intended, but in almost every case I have noticed that such drawings were inaccurate and were by no means faithful to the original. As I pointed out in my paper even *the diagram* in Mr. Maudslay's own admirable work errs somewhat in this respect. I have studied his *photographs* carefully on several occasions, and I must confess I remain quite unconvinced, in common with many others who have far more expert knowledge of the subject than I can lay claim to, that the sculpture is intended for an elephant, nor, with all deference to Professor Elliot Smith, can I discover the least indication of tusks.

The elephant controversy apart, I note that the Professor avoids entirely the main point at issue—namely, my total

disagreement with his thesis that the Maya culture was directly inspired by the Cambodian, and in support of which he relies so emphatically on the so-called elephant's head as an argument. He is good enough to suggest that my contentions are illogical, but I confess I find it difficult to imagine anything more so than his own, which amount to this—that the earlier culture of the Mayas is inspired by another, to wit the Cambodian, which very considerably post-dates it!

From whatever quarter the Maya culture was inspired, it could not at any rate have been from Cambodia. The dates absolutely preclude it. I still believe that this culture was indigenous and that those who so dogmatically deny it, because we have as yet found no traces of its beginnings, are making claims which, in the present state of our knowledge, are premature and unwarranted. They ignore entirely the fact that scarcely anything in the way of real *excavation* has yet been carried out on any of the ancient Maya sites. The work done so far has been almost wholly confined to the surface. In the few cases where any digging has taken place, a considerable antiquity *in situ* is indicated. I may quote on this point Mr. G. B. Gordon who was for a time in charge of the work carried on at Copan by the Peabody Museum, of Cambridge, Massachusets, some years ago :—

> "Wherever excavations have been made at Copan in the foundations of structures, and even below the level of the great Plaza (on which most of the dated Stelae are situated), the remains of other walls and terraces and pavements have been found, and certainly the whole of the main structure is built over the remains of older structures; and in some parts at least the older works occur not in one layer only, but in several distinct layers corresponding to different building periods."

This is, to say the least, suggestive.

EDWARD C. RASHLEIGH.

Books Received.

A Summary of Physical Chemistry. By K. ARNDT. Translated by W. H. PATTERSON, M.Sc. (Methuen & Co. Ltd. 3*s.* 6*d.* net).

Annals of Archaeology and Anthropology. Vol. XII. Nos. 1-2. June, 1925. (University Press of Liverpool. 12*s.*).

The Heating of Rooms. By MARGARET FISHENDEN, D.Sc., F.Inst.P., Fuel Research Board. No. 12. (H.M. Stationery Office. 1*s.* net).

Intermediate Light. By R. A. HOUSTON, M.A., Ph.D., D.Sc. (Longmans, Green & Co. 6*s.*).

A System of Physical Chemistry. By WM. C. McC. LEWIS, M.A. (R.U.I.), D.Sc. (Liv.). Vol. II. "Thermodynamics." (Longmans, Green & Co. 15*s.* net).

The Future. By PROFESSOR A. M. LOW, F.C.S., F.R.G.S., M.I.A.E. (Routledge & Sons. 5*s.* net).

School History of Science. By J. A. COCHRANE, B.Sc. (Edward Arnold & Co. 2*s.* 6*d.*).

The Riddle of the Earth. By APPIAN WAY. (Chapman & Hall Ltd. 10*s.* 6*d.* net).

S.P.E. Tract No. XXI: The Society's Work. By ROBERT BRIDGES. (The Clarendon Press. 2*s.* net).

Historic Scientific Instruments. By R. T. GUNTHER. (Oxford University Press. 2*s.* 6*d.* net).

Atmospheric Pollution. The Meteorological Office. Air Ministry (H.M. Stationery Office. 4*s.* net).

Psyche. No. 21. July, 1925. (Kegan Paul. 5*s.*).

Meteors. By CHARLES P. OLIVER. (Bailliere, Tindall & Cox. English Agents. 15*s.* net).

Intermediate Mathematics (Analysis). By T. S. USHERWOOD, B.Sc., Wh.Ex., A.M.I.Mech.E., and C. J. A. TRIMBLE, M.A. (Macmillan & Co. 7*s.* 6*d.*).

Bulletin of the Imperial Institute. Vol. XXIII. No. 2. 1925. (John Murray. 3*s.* 6*d.* net).

Evolution, Heredity and Variation. By D. WARD CUTLER, M.A. (Cantab.), F.L.S. (Christophers. 4*s.* net).

Varia. A Miscellany of Verse and Prose, Ancient and Modern. Compiled by ELEANOR M. BROUGHAM. (Wm. Heinemann Ltd. 8*s.* 6*d.* net).

The Mind and its Place in Nature. By C. D. BROAD, M.A., Litt.D. (Kegan Paul. 16*s.* net).

Coal and Iron. By W. MARGRIE. (Watts & Co. 1*s.* net).

A Classbook of Botany. By ERNEST STENHOUSE, B.Sc. (Macmillan & Co. 7*s.* 6*d.*).

Smoke: A Study of Town Air. By J. B. COHEN, Ph.D., F.R.S., and A. G. RUSHTON, B.A., D.Sc. (Edward Arnold & Co. 8*s.* 6*d.*).

An Elementary Chemistry. By E. J. HOLMYARD, M.A., F.I.C. (Edward Arnold & Co. 4*s.* 6*d.*).

Phases of Modern Science. Published in connexion with the Science Exhibition arranged by a Committee of the Royal Society in the Pavilion of H.M. Government at the British Empire Exhibition, 1925; and including the Handbook to the exhibits. (Sold by A. & F. Denny Ltd. 3*s.* 6*d.*).

Thamyris: Or is there a Future for Poetry. By R. C. TREVELYAN. (Kegan Paul. 2*s.* 6*d.* net).

Heat: An Elementary Textbook. By IVOR B. HART. (G. Bell & Sons Ltd. 3*s.* 6*d.*).

A Tentative Classification of Long Period Variables. By LEON CAMPBELL. (Harvard Reprint 21.)

Seventy-ninth Annual Report of the Director of the Astronomical Observatory of Harvard College. For the year ending 30 September, 1924. By HARLOW SHAPLEY. (Cambridge. Mass. Published by the University).

Annual Report of the Geological Survey Dept. For the year ended 31st December, 1924. (Printed by the Government Printer, Uganda).

Oscillographs. By J. T. IRWIN. (Sir Isaac Pitman & Sons Ltd. 7*s.* 6*d.* net).

Concerning the Habits of Insects. By F. BALFOUR-BROWNE, M.A., F.R.S.E., F.Z.S., F.E.S. (Cambridge University Press. 6*s.* net).

Book Reviews.

Bibliographie de la Relativité. By MAURICE LECAT. (Brussels: Maurice Lamertin).

This very comprehensive compilation contains all the important, unimportant, good and bad contributions to the theory of relativity that seemingly have appeared anywhere. Even a review by the writer in DISCOVERY of a book he thought was bad is included. What incited the industrious compiler to undertake this prodigious labour I know not, but there is no question that he has been thorough. He finds the first reference to the subject in the work of one Bradley in 1728, and he has found no less than forty references before the year 1875. The output of papers on relativity attained a temporary maximum in 1911 and, after declining during the war, reached the highest point in 1922. In that year nearly 550 papers were written, but there is no means of knowing what proportion of these was understood or even read. The book appears to be accurate. It is well printed, and though the cover is of paper it is neatly got up.

A. S. R.

Rejuvenation. By NORMAN HAINE, Ch.M., M.B. (Allen and Unwin. 7*s.* 6*d.* net).

Steinach, Voronoff and other workers have in recent years achieved considerable and sensational publicity. There is a great deal of popular misconception concerning the application of their discoveries, and this book, which summarizes the situation and describes the technique and results said to follow, is extremely interesting.

It is a book for the information of the layman and medical man alike, and it discusses the different methods and theories of the various schools and the success or failure of their work in human cases. A good bibliography is appended. The author is not able to express any definite opinion on the point of whether human life is prolonged by the treatment, but summarizes the sexual rejuvenescence achieved in a number of recorded cases. The book will not appeal to those who are dubious of the wisdom and the desirability of revitalizing old men. The list of cases given will do little to convince them that the community in general are likely to benefit.

The Origin of Man. By CARVETH READ, M.A. (Cantab). Second Edition. (Cambridge University Press. 1925. Pp. xii, 100. Price 5*s.* net).

Man and his Superstitions. By CARVETH READ, M.A. (Cantab). Second Edition. (Cambridge University Press. 1925. Pp. xvi, 274. Price 12*s.* 6*d.* net).

Professor Carveth Read has elected to publish the second edition of his valuable and original study of the physical and mental evolution of man in two volumes, each complete in itself, for the convenience of readers who may be interested in one side only of his subject. The original work is considerably expanded but its main theses remain unchanged. For the benefit of those who are not already acquainted with Professor Read's theories it may be stated that his object is to show the *why* rather than the *how* of man's evolution. For instance, he holds that the change from the arboreal to a terrestrial form of life in the precursors of man was due to a change, or rather extension, of diet which turned them into hunting animals—a change which at the same time led to the development of mental qualities leading up to the specifically human. The influence of superstitions and religious beliefs is treated on similar lines. Professor Read's incidental observations on the logical canons to which anthropological argument should conform, are as welcome as they are needed.

The Nature of Intelligence. By L. L. THURSTONE. Professor of Psychology, Carnegie Institute of Technology. (Kegan Paul. 10*s.* 6*d.* 1924.)

The scope of Professor Thurstone's book is wider than its title indicates, for his aim is to build up a psychological theory and practice that shall combine the valid elements of the new analytical psychology with the methods and findings of the older schools of Academic and Behaviouristic psychology. He finds no actual disparity between the three schools, but only a divergence in the angle from which the individual is studied. Analytical psychology studies the individual in terms of his desires; Academic psychology his mode of reaction to environment; Behaviouristic psychology studies the end result in conduct.

Professor Thurstone proposes to define consciousness as "the life impulse in process of becoming conduct," a point of view that embraces the three centres of interest.

Actually, Professor Thurstone inclines to the new rather than the old psychology, for although analytical psychology, untrammelled by the scientific discipline and rigorous logic in which the older schools have developed, has led to strange and extravagant conclusions, yet he finds a fundamental truth in its basic assumption that "action begins in the individual" and not in his environment.

Right throughout the book interest is focussed upon what the individual wants to do, rather than upon what he does or how he does it, and the author's scheme is summed up in the epigram "psychology starts with the unrest of the inner self, and it completes its discovery in the contentment of the inner self."

The author, unlike Professor Bergson, sees an unbroken line of development from the instinctive action of the lower animals to the rational action of man. He sees an instinctive action as "an impulse, usually strong, which does not meet any interference until it reaches the perceptual stage of completion," while in more fully conscious, rational action the impulse is inhibited at an early stage of its career before it has become focussed upon its goal, with the result that a number of alternative paths are opened up for it, and a wider variety of reaction is made possible. Consciousness is defined again, more strictly, as "the presence of impulses that have been more or less defined and which conflict with one another and thus arrest their own expression (in action)." This definition is likely to provoke criticism since it does not admit that there can be consciousness without at least the germ of impulse.

The criterion of intelligence is almost implied in the comparison between rational and instinctive action, and is formulated as "the capacity to make impulses focal at their early unfinished stage of formation." Intelligence is therefore an inhibitory process, and it follows that the individual with powerful impulses will have more difficulty in arresting them in their course towards expression in action and will, therefore, be less capable of abstract conceptual thinking than the individual in whom the impulses are weaker.

Professor Thurstone's book is a valuable contribution to the literature of psychology, and will be welcomed especially by those who find the older psychology a little sterile and the newer rather fantastically prolific.

A General Textbook of Entomology, including the Anatomy, Physiology, Development and Classification of Insects. By A. D. IMMS, M.A., D.Sc. (London: Methuen & Co. Ltd. 36*s.* net).

It is a happy coincidence that the same month saw the publication of the last part of Volume II of Berlese's "Gli Insetti," and of Dr. Imm's comprehensive memoir on Entomology. The latter, without perhaps being quite so detailed or long as the former book, is a very compendious volume. It deals comprehensively with the physiology, the development and classification of the insecta, and gives a really stimulating account of the biology of the more important groups. So large is the subject that the writer has perforce to omit certain aspects such as palæontology, in which marked advances have recently been made by British and other researchers, notably by Tillyard of New Zealand. Further, in his preface Dr. Imms tells us that he has been able to make "only brief reference to problems of insect behaviour, ecology, coloration, cytology, etc."; still, these brief references are full of interest. For instance, his discussion of structural colours with his abstract of the important results attained by Onslow is a clear and concise account of a very difficult problem.

> The subject is very fully discussed by Onslow (1921), who believes that diffraction alone is seldom the cause of iridescent colours, and that interference is a factor of great importance. In the case of the Lepidoptera this view is enormously strengthened by the presence of a regular periodic structure of the correct magnitude in their scales. This structure is formed by plate-like striae (1,000-16,000 to the cm.) which are separated by thin films of air. The width and height of the striae and their distances apart greatly affect the colour produced. There are also certain cases (e.g. *Papilio ulysses*) in which the periodic structure is produced by layers of transparent chitin parallel to the surface of the scales. White may be produced by air in scales, by the flat faces of crystals, or by fine granules which give total reflection.

In his account of the segmentation of the insect body Dr. Imms attributes six segments to the head, three to the thorax, and eleven to the abdomen, and ignores the third embryonic segment which is described as occurring between the antennae and the mandibles and disappears in the embryo. If this be counted we have a total of twenty-one segments, which brings the insect into line with certain of the higher crustacea and arachnids, which are alleged to be built up of twenty-one segments.

To give an example of the care and thoroughness with which Dr. Imms deals with the anatomy of the insect we may for a moment consider what he has to say about the fat-body. The fat-body, which is always rather a nuisance to students in dissecting an insect, is either white, yellow, orange or greenish; its tissues are derived from the mesoderm and built up by the differentiation of the walls of the primitive coelomic cavities, and primitively it is metamercally arranged. But with the breaking down of the embryonic coelome the fat-body forms irregular boundaries to the permanent body-cavities. In some cases, however, part of it forms a parietal layer lining the body-wall and another part forms the inner or visceral layer in which the alimentary canal and other organs are embedded. At first the nuclei of the cells which build up the fat-body are rounded or oval. Later they frequently become elongated or star-shaped. Everywhere the fat-body is soaked by the blood and from the blood it absorbs and stores up such products of digestion as are for the time in excess of those necessary for the maintenance of normal life. Sometimes these are in the form of albuminoid granules, but the most usual reserve material is fat. Urates are also deposited in these tissues, and to them is usually due the colour of the organ. As a rule the fat-body is most prominent in the larval stage, and its accumulated nutritive material is drawn upon during the breaking up and rebuilding of the tissues, and again during the reproductive process. Again they form a useful reserve material in the case of those insects that hibernate. In insects with a complete metamorphosis urates, which have accumulated during the larval and pupal stages, are discharged from the alimentary canal of the imago.

The chapter on the classification of insects, followed as it is by a detailed account of each of the twenty-three orders, is very thorough and very interesting. As examples may be mentioned the account of the domesticated cockroach, and on the following, page the various legends connected with the *Mantis* or praying insect; and all through this part of the book one finds a very human touch.

In conclusion one may add that the book is extremely well illustrated. Many of the illustrations are new, but the majority are borrowed from sources which are not very readily available, and undoubtedly the copious and well-executed figures add greatly to the value of the treatise. It will be of use not only to the expert entomologist, but to the beginner, for as he proceeds on his capable exposition the author explains new terms as they arise. There are further two admirable indices, and the single criticism one has to make is that the use of large black type for various subdivisions, families, sub-families, authors, etc., somewhat spoils the appearance of the page.

A. E. S.

The Future. By PROFESSOR A. M. LOW, F.C.S., F.R.G.S., Fellow of the Institute of Patentees, etc. (Routledge. 5*s.* net.)

Neither the preface nor title page of this book disclose precisely where Professor Low holds a chair, but he has the gift of platitude. Nobody could read his vision of the future without thanking God for the mercy of mortality. One would think that the vast canvas of a thousand years of future time would inspire the meanest artist to a glimpse of other than a plumber's vision. Yet to the author a dream of the future is but a nightmare of minor mechanical advantages and technical appliances of dubious worth. An advocacy of polygamy and a prophecy of illegitimate operations on an open and recognized scale represent an attempt to be progressive.

It is a matter for regret that the book is heralded as being scientific; it is very much more like the output of a group of very young students at a provincial Polytechnic. Were we to adopt the Professor's style and idiom our verdict could be even more concise.

Hunting and Adventure in the Arctic. By FRIDTJOF NANSEN. (J. M. Dent. 15*s.* net).

This is the tale of young Nansen's first trip to the Arctic. It is one of those pleasant simple books of travel, adventure and reminiscence that has a particular charm of its own. Here we have Dr. Nansen in his proper setting as a young scientific worker with all a boy's love of sport and adventure. The book is an ideal present for a boy of any age, and brings with it some of that queer glamour and interest of the great ice-fields that has set out explorers' hearts toward Polar exploration. Seal-hunting, polar bear shooting and all the savage joys of the ice floes are well described, and the book is abundantly illustrated with sketches by the author.

Kant's Treatment of Causality. By A. C. Ewing, D.Phil. (Kegan Paul. 10*s.* 6*d.* net).

In this book Mr. A. C. Ewing, D.Phil., late Heron Exhibitioner of University College, Oxford, is concerned with expounding and criticising Kant's thought in a single category abstracted from the rest. Causality, as the chief of the categories and the fundamental postulate of all science and experience, is naturally the one chosen for the purpose; and what the author particularly seeks to demonstrate is that, though Kant's statement of his proof of the principle of causality is too much bound up with other parts of his particular system of philosophy to meet with general acceptance, it is possible to restate it in a form in which it can stand by itself and make a good claim for acceptance on all schools of thought.

The book opens with a careful study of the treatment of causality by Kant's predecessors, Locke, Berkeley and Hume on the one hand, and Leibniz and Wolff on the other. There follows a chapter on the development of Kant's conception of causality up to the Critique of Pure Reason; then, in order to give the reader the necessary preparation for Kant's later proof of the principle, the author gives an exposition of that part of the Critique known as the transcendental deduction of the categories, in which Kant seeks to show that the categories, though *a priori*, must have objective validity. Preliminary work completed, we next pass to the Analytic of Principles, where Kant, after expounding the mathematical principles all experience falls under, sets out the dynamical principles, or three Analogies of Experience, as he calls them—the principle of substance, the principle of causality, and the principle of reciprocity. These, of course, constitute the very essence of the Kantian philosophy, since it is mainly in these three principles and their proof that Kant gives his final and long-worked-out answer to Hume's denial of the necessary relationship of cause and effect, which had been greatly the cause of his entering upon the critical inquiry. Hume, it will be remembered, had maintained that the principle of causality is nothing more than a subjective habit of mind due to repeated experience of identical sequences. He had stated that all we really observe in contemplating Nature is succession and change; that, as far as the objects observed are concerned, there is in fact, no difference between observed succession and causation, and he had contended that the so-thought necessary connexion which the mind forms of changes in the external world is nothing more than a habit our minds have formed from custom, due to continually seeing the same succession. Now Kant, in answering this scepticism of Hume, universalised the problem. By asking, How is consciousness of a world of objects all related as parts of one space and one time possible? he extended it not only to the principle of causality, but also to the principles of substance and reciprocity; and the answer he arrived at was that it is only possible by reason of these principles being *a priori* conditions of consciousness. The principle of causality cannot have come from experience, because it is necessary to experience; consciousness of succession does not lead to causality, because without the principle of causality there could be no consciousness of succession. And likewise with the principles of substance and reciprocity. Repeated experience of the same perception or object cannot explain the conviction that there is in objects something which, throughout all change, remains identical with itself and can neither increase nor diminish, because consciousness that an object or perception is the same in its recurrent appearance is only made possible by the principle of substance; and in the same way, repeated co-existence of objects in one space cannot have implanted in us the belief that they are reciprocally necessary to each other, since without the principle of reciprocity existed *a priori* in the mind, objects could never be determined as coexisted in one space. In short, Kant contends that the three principles of substance, causality and reciprocity cannot have come from experience because they themselves are instrumental in constituting experience; and he proves all three, on the transcendental method, by showing that there could be no systematic unity of experience, no consciousness of a world of objects and events all related as parts of one space and one time, without these principles were *a priori* conditions of consciousness.

It is mainly with the second Analogy rather than the three principles together that Mr. Ewing is concerned. He deals with Kant's proof of the principle of causality in the most able and lucid manner, both expounding it and defending it against a number of alleged weaknesses; but what he mainly seeks to demonstrate is that the main principle of the Kantian proof of causality—that experience would be impossible without it—can be accepted, not only without assuming Kant's particular system, but without assuming any form of idealism. "We must, of course, admit," he says, "that Kant takes an idealist standpoint throughout the argument, that he logically bases all his conclusions on the doctrine of transcendental idealism, and that he supposed this doctrine to be necessary if the validity of the categories was to be proved at all; but it seems to us that it is not the doctrine but only the method of transcendental idealism, i.e., the method of proof by appealing to the possibility of experience and knowledge, that forms the real presupposition and basis of the deduction of causality." In other words, Mr. Ewing's contention is that the essential part of Kant's message on the subject of causality is not that the mind arranges (synthesises) Nature according to the category of causality, but that we can prove the universal principle by showing that without it knowledge would be impossible; that if we can prove causality to be valid of phenomena because otherwise we could not know them, we do not (as far as this point is concerned) necessarily need any further help from the subjectivial standpoint, whatever may be the case of the explanation of knowledge considered epistemologically.

Having reached this conclusion with relation to causality, and shown precisely what Kant succeeded in proving in this respect, Mr. Ewing goes on to deal with the application of the categories to the empirical self, the First Cause Antinomy forming part of Kant's treatment of Rational Cosmology, and also the problem of Freedom. In all these problems he again displays a very full and accurate knowledge, and the main point he emphasises is that, as Kant only proves necessary succession of phenomena (as opposed to mechanical causality), it is highly probable that some at least of these problems can be dealt with without encountering the difficulties many philosophers have imagined. To the scientist-philosopher Mr. Ewing's work should certainly prove pleasing; for his main theme is that, whatever be the true explanation of knowledge, the fundamental postulate of science can be adequately proved without the idealist extremes some metaphysicians consider such proof necessarily involves.

N. C.